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I. HOW SCIENCE TEACHING IS FOSTERED BY THE STATE.

It is rather more than three years since there appeared in these pages an article upon that department of our executive which supports, or at least professes to support Science tuition in this country.* We there briefly reviewed the history of the movement, pointed out the defects in its management, and expressed an opinion as to its future, which it will now be found was not arrived at without proper consideration.

As a Committee of the House of Commons is about to be nominated to inquire into the whole system of scientific and industrial training for the artizan classes in England, and as the subject has of late absorbed a large share of public attention, it may be instructive for us to return for a moment to the earlier phases of the movement, and compare them with its present aspect.

As we stated in our former article, the scheme of Science teaching was originally set on foot by the Conservatives, Lord Salisbury being President of the Committee of Council on Education. The Government enlisted the services of men of Science as teachers, by offering them small annual payments upon their obtaining certificates of competency at South Kensington (varying from 10*l.* to 20*l.* according to the grade of the certificate for each subject in which they gave instruction); and it further sought and readily obtained the honorary aid of persons throughout the country, who from disinterested motives were willing to act as members of committees to see the Government grants fairly applied.

There were other inducements, such as prize-fees, held out to teachers to raise up intelligent men of Science from amongst the artizans of the country; and as to the latter, that is to say the students, they received handsomely bound books called Queen's Prizes, and were invited to compete for gold, silver, and bronze national medals.

* "The Science and Art Department," 'Quarterly Journal of Science,' No. V. (vol. ii.), July, 1865.

Those liberal measures had the effect of calling into existence a large number of Science schools and classes, which were well attended by intelligent artizans, and were, as a rule, ably presided over by teachers of no mean scientific attainments.

A change of Government, however, initiated a new, if not a wiser policy, and when Mr. Lowe took the direction of affairs he extended the system of "payments on results," with which he was, and still appears to be, so well pleased, to the Science teachers of the country; and whilst he effected a considerable reduction in the payments made to those gentlemen who were already engaged in the work, he, or the department under him, made great efforts to establish new classes, and to swell the list of pupils and teachers which is published in each new 'Directory.'

It is not very difficult to anticipate what would be the result of such a change. Teachers who had been receiving 100*l.* or 150*l.* from the State, soon found their incomes dwindling away to one-half or a fourth of that sum, and when the Government issued a "recommendation," as they did soon afterwards, that the fees of students should be increased to meet the deficit, accompanied by the gentle hint that State aid was liable to be withdrawn altogether, the School Committees had no alternative but to follow their instructions, and to drive away a considerable number of those persons, both pupils and teachers, who had been attracted by the bounty of the State. Between the years 1860 and 1864, with a rapidly-increasing list of teachers, entailing an amount of work *which rendered it necessary to double the sum expended in the management at South Kensington*, there was hardly any increase in the estimates for the payment of teachers, so that practically the Government was "robbing Peter to pay Paul;" and it was at this stage of the movement that the article appeared in which we pointed out the injustice and impolicy of such a proceeding, and predicted that it would have a most injurious effect upon the scientific education of the people. Our remarks concluded with an explanation of the reason why the Science teachers had not protested against the breach of faith on the part of the State, and it simply amounted to this: they had been decoyed into a profession, for which they were willing to make great sacrifices; they were comparatively few in numbers; and any resistance to the heads of the department would only have made its initiators marked men, and might have subjected them to great annoyance.

They suffered as long as they could, and many of them were compelled for a time to live upon a pittance which we should consider it an insult to offer to a skilled labourer. One gentleman (one of the best teachers in the three kingdoms), who was at first in receipt of a fair income from the State and from his pupils, many of whom were distinguished by the possession of valuable medals,

retired from the profession and now occupies a humble, but at least an honourable appointment in connection with one of the learned societies. Another (a Doctor of Science of London University), recently deceased, who was the ablest teacher the department could boast, and whose certificates were high and numerous, received about 100*l.* for teaching one large class at the commencement of his career, and by extraordinary industry raised his income to twice or three times that amount; whilst at his death he was giving instruction in three different towns, and as far as our memory serves, his whole remuneration from the State amounted to about 30*l.* or 40*l.* He, too, was seeking gradually to free himself from the connection with South Kensington by practising as an analytical chemist, and, had he survived, would not long have remained a servant of the State. These are by no means isolated examples, not only of what has happened, but, as we shall see presently, of what is still taking place amongst our best teachers and institutions.

Then as to the Committees. Finding the support of the State gradually withdrawn, and the number of students rapidly diminishing in consequence of increased fees, perceiving in fact that their vessels would be allowed to run ashore wherever it pleased the tide to drift them, the gentlemen who had acted as pilots either deserted them or became indifferent to their fate. The teachers were allowed to take matters under their own management; secretaries played into their hands; examination papers were opened before the authorized hour, and copies of them sent to the teachers who were waiting outside to put down the answers; these were sent back and surreptitiously delivered to the students, who came off with flying colours and carried away prizes and medals in triumph. Of course this oozed out at length, and then "My Lords" issued an indignant circular, informing committees of those practices, stating that they had cancelled the papers of such and such classes, and rendered the regulations still more stringent and distasteful to gentlemen of honour, who were giving their valuable time gratuitously to the service of the State. Teachers and students were alike disgusted. How did they know for what length of time these practices had been carried on, and how many medals they had lost in consequence? And how did they know whether these transactions might not still be taking place to their prejudice?

But it may be objected on the part of those who uphold the present system that the number of schools has largely increased during the last few years notwithstanding all these defects; and we may be told that whilst in 1865, the year following the appearance of our article already referred to, the 'Directory' only noted the existence of 121 Science schools in the three kingdoms, that of 1867 gives us a list of 213 such institutions.

Whether this is a fair test of the success of the system, or

whether it is not rather the result of factitious means which have been employed to create a false appearance, we shall now proceed to consider, first from the printed statistics of the department, and secondly from those sources that have been laid open to us by the managers of the various institutions which have been affected by the system.

The following schools were in existence in 1865 with the number of students placed opposite their names; *those schools are now entirely closed,* at least their names do not appear in the 'Directory' of 1867:—

Name of Town.	Institution.	Number of Pupils. 1864.	1865.
Ancoats	Educational Institute	—	32
Brentford	New British School	—	40
Christchurch	Working Men's Institute	—	25
Dudley	Mechanics' Institute	52	30
Duckenfield	Village Library	—	16
Exton	Boys' School	—	11
Glossop	Working Men's Institute	—	16
Gulworthy	Duke of Bedford's School	20	12
Kidderminster	Mechanics' Institute	14	10
Loughborough	Town Hall	24	23
London	Farringdon Street British School	200	50
"	Shadwell Sailors' Institute	32	19
Macclesfield	Mechanics' Institute	44	26
Marsden	"	15	14
Netherton	"	24	21
Newcastle-on-Tyne	"	42	31
"	Iron and Alkali Works School	—	15
Rawtenstall	Holly Mount	17	20
Redditch	Literary Institute	38	40
Slaithwaite	Mechanics' Institute	12	14
"	Meek and Walkers	—	18
Staleybridge	Mechanics' Institute	—	30
St. Day	Girls' School	18	12
Stourbridge	Grammar School	9	25
Tintwistle	National School	14	11
Upton	St. Leonard's Schoolhouse	30	40
Wells	Mutual Improvement Society	—	9
Bandon	Town Hall	—	20
Dublin	Athenæum	—	28
"	Christian School	—	190
"	Christian Brothers' School	—	29

Thirty schools, therefore, including those at such important centres of industry as Dudley, Glossop, Macclesfield, Marsden, Newcastle-on-Tyne, Staleybridge, and Stourbridge, have already disappeared; and if it had not been for the devotion manifested by teachers, or the repeated appeals of committees to raise the necessary funds for paying those teachers even a small pittance to retain their services, the number of *important* schools which have been closed would have been largely augmented.

And now turning from the 'Directory' of 1865 to that of 1867, let us supplement the inquiry concerning the schools that

have been closed by another, as to where they have never been opened. There are no institutions for Science teaching at Sheffield or Rotherham, none at Bradford, Dewsbury, Rochdale, Newark, Stoke-upon-Trent, Coventry, Birkenhead, Sunderland, and a vast number of other towns constituting the centre of trade or manufacture, and whilst we find in the list such important localities as Alderly Edge with a diminishing class of 14, Breage with 12, Clitheroe also with a decreasing school of 12, Congleton with 21, Cottesmore with 22, Denton with 10, Guisborough with 7, Kettering and Kingsbridge with 21 and 12 respectively, and a number of other similar places of whose existence many of our readers are probably not aware, we are cheered by finding that *Leeds has one school with* 39 *students, and that* 12 *persons in all are receiving instruction in Science in the important town of Wolverhampton.*

These, then, are some of the towns in which the schools have either been closed, or have never been opened; now let us turn for a moment to the condition of some of the more important ones still in existence—but which cannot long continue open unless the present system of granting aid is changed—and for this purpose we shall pass beyond the printed reports of the department and avail ourselves also of those which we have ourselves received from various parts of the country.

The following are the statistics of the department which show how some of the most important schools have declined or are declining:—

Name of Town.	Institution.	Number of Pupils. 1864.	1865.	1866.	1867.
Bolton	Mechanics' Institute ..	50	55	95	79
Burnley	„	69	24	60	48*
Cardiff	Free Library	—	—	56	42
Halifax	Working Men's College	21	38	15	17
Huddersfield ..	Mechanics' Institution	20	33	26	16
Liverpool	School of Science ..	125	37	28	68†
Manchester ..	Mechanics' Institute ..	291	281	388	239
„	Corporation Street ..	52	52	42	36
Nottingham ..	Mechanics' Institute ..	17	82	75	35
Oldham	Parish Church Schools	149	85	—	19
Salford	Working Men's College	65	41	53	44
Slough		41	66	65	62
Torquay	School of Science	—	—	70	36
Wigan	Mining School	92	93	30	23‡
Yarmouth	Navigation School ..	146	163	139	112§
Aberdeen	Mechanics' Institute ..	48	34	91	69

Thus it will be seen that besides the fact of there being no schools at all in a considerable number of our most important

* This year this school has still further declined; the number of pupils being 45.

† Again falling off this year.

‡ This school was to have been closed this year, but a visit from an emissary of the department has revived it after a fashion.

§ Still further decreased this year; number of pupils 85.

manufacturing and seaport towns, either because none have ever been established, or because after endeavouring to struggle against their difficulties for a short period they were compelled to close, we find a large number of the old schools in still more important towns either about to close, or with little prospect of enjoying a long existence. But an objection will be raised to our choice of figures, that we have not made any mention of new schools being opened in *some* (for it is only in a few) of the towns where the old ones are on the decline; and that objection we shall meet by describing the kind of procedure by which the present system has been upheld.

A school would be established, we will say at the town of A. Probably some zealous teacher had enlisted the co-operation of a committee of gentlemen (or *vice versâ*), the department would then be communicated with, and the necessary forms filled up. For a time the school would prosper: when the system of "payment on results" was introduced, remonstrances would be sent from the Committee to the Department, which would meet with no attention, or would be met by the "*non possumus*," which is as much in vogue at South Kensington as at Rome; this would probably be repeated year by year, until at length teacher, committee, and every one else concerned being disgusted with the treatment they had experienced, it would be decided to close the school, and notify the same to the department. Then an emissary of the department would make his appearance in the town, and if it was a small one where it would be useless to attempt the formation of a second school, he would go to the authorities (as it happened recently at Wigan), and would induce them to call a town's meeting, and attempt to resuscitate the school, attributing the failure, of course, to every cause but the true one. If, however, there were more institutions in the town capable of having Science classes attached to them, they would be probably visited and induced to start classes; and in the following 'Directory' another, or perhaps two new schools would appear on the list for the town of A, with what likelihood of permanent success we leave our readers to surmise. But if on the one hand we have omitted to give the names of some new schools where the old ones are on the decline, we have also passed over the names of some very considerable schools which appear to have been closed, inasmuch as we can hardly credit the fact, and think perhaps the omission may be susceptible of explanation. For example, we find in the 'Directory' for 1865 a navigation school at Plymouth, which had in the years 1864–65, 240 and 243 pupils respectively; whilst in that of 1867, we find the school named it is true, but no return of pupils either for 1866 or 1867. What is the reason of this? And again, at Newcastle there were in 1864–5 *three* schools, two of them being Science

schools, and one a navigation school. None of these appear in the 'Directory' for 1867, two seem without doubt to have been closed; but what has become of the navigation school, which in 1863–4 had 139, and in 1864–5, 165 pupils?

That there is something here which needs explanation, our readers will not doubt, and whatever else Parliament may think fit to do, or to leave undone, we trust it will make a searching inquiry into the condition of our navigation schools; that there are good grounds for such an inquiry will be seen presently. And now, having expressed our own disapproval of the system upon which the State dispenses the public funds in aid of Science, it becomes necessary that we should support this view by the opinions of others better able, perhaps, than we are to judge in the matter; although we may be permitted to add that our conclusions have not been formed without long-continued personal observation of the proceedings of the department and of their effect upon the country.

The Science teachers and committees have now so little to expect from the State, and so little to thank it for, that it has needed no persuasion to induce them to lay bare their grievances and expose the condition of the institutions over which they preside, and from the numerous special reports which we have received, we will now select a few and print them *verbatim*.

Great Yarmouth School of Navigation.—The school was established in 1857. The year preceding the system of payments on results there were two teachers whose remuneration was as follows:—

	£	s.	d.		£	s.	d.
From the State.. ..	180	0	0	Head Master	120	0	0
				Assistant ditto ..	60	0	0
„ Students ..	53	12	5	Head Master	39	14	4
				Assistant ditto ..	14	8	1
	£233	12	5				

The school then had 138 pupils; since that time there were at one period 168. *Now* it has one master and 85 pupils. The remuneration of the former is 100*l.* in all, namely, 40*l.* 4*s.* 10*d.*, "payments on results," and the remainder school-fees. "For the past three years this school has been kept in action with difficulty, and a question arose in the autumn of last year whether it should be entirely closed. We decided to try another year, trusting to some amelioration either in the attendance or Government aid. A comparison of the figures under the two systems shows the hardship upon the teacher."

The following is from Mr. Shore, the "Organising Master of the East Lancashire Union of Mechanics and other Institutes":—

Burnley, established in 1858, had (the year preceding the

system of payments on results) about 30 or 40 students and one teacher (no account kept of remuneration): has had 48, and has now 45, students. Total remuneration from the State, 17*l.*, and beyond some trifling charge made for chemicals "the Committee do not guarantee the teacher any remuneration."

"The classes are fluctuating: payment on results is not the best basis for a scheme for Science teaching to rest on, for it stimulates cramming and indirectly discountenances practical work. The examination questions vary from year to year in their difficulty so much that teachers are not only dependent on their pupils, but at the mercy of the whims of the examiner. The system can never become a total success, as no encouragement is offered by 'payments on results' for teachers to devote themselves specially to Science teaching."

Mr. Shore also sends us equally disheartening details of schools and classes at Padiham, Haslingden, and Bacup—all struggling to keep afloat; at the place last named three teachers receive amongst them about 30*l.*!

Slough.—(The secretary, Mr. Chapman, sends us the following.) The school was established in 1853. The year following the introduction of the system of payment on results, it had 50 students, and one teacher who received remuneration as follows:—

	£	s.	d.
From the State	19	10	0
„ Students		Nil.	
„ Committee	4	0	0
	£23	10	0

Now the Master has 75 students, and receives as follows:—

	£	s.	d.
From the State	12	0	0
„ Committee	4	0	0
	£16	0	0

Here we have an encouraging view of the system of "payment on results"—25 more students, and 7*l.* 10*s.* less for teaching them!

Concerning this school the Secretary writes. "The members" (students) "are chiefly composed of carpenters, bricklayers, painters, blacksmiths, and the usual trades and occupations belonging to a small agricultural town." "Eight of the class have obtained master's certificates in plane, practical, and solid geometry, and two in building construction, three of whom are now engaged at different places as Government Science teachers." "The course of instruction is plane geometry, isometric and orthographic projection, descriptive geometry, perspective, building construction, plan drawing, orna-

mental painting (for house-painters), free hand drawing from the "flat" and "round," modelling for stonemasons, wood-engraving, mensuration, and valuation of work. Thus you will perceive the subjects are generally useful, and our course is not confined to the simple Science and subject for which the master has gained his certificate." "Numbers of our men have gone away and taken situations of great importance and responsibility with perfect success." *

Here we have *results*, which the State rewards with the munificent sum of 12*l.* per annum!!

Nottingham.—School established in 1861. There were originally three teachers, now there is only one who receives—

	£	s.	d.
From the State	8	10	0
„ Students	4	5	0
„ Committee	Nil.		
	£12	15	0

for which he teaches inorganic chemistry to 21 students, geology to 8, physiology to 30.† "Our greatest difficulty has been that of obtaining teachers, in consequence of the insufficiency of the remuneration."

Two other circumstances have forced themselves upon our attention during the perusal of the various reports which we have received. One is that the 'Directory' presents a more favourable view of the action of the State from there being included in it the names of schools (some of the largest by the way) which were in existence, and where all the subjects which are now mentioned were already taught before the system of State aid commenced. This is the case at the Manchester Mechanics' Institution, where "Science has been systematically taught since 1857 before the Government Science system was devised;" and to show how much has been gained by the introduction of the system there, we need only refer to the preceding table extracted from the Directories, from which it will be seen that whilst in 1864 the number of students was 291, it was in 1867, 239.

Another circumstance is that the work of establishing good schools is done by persons unattached to the State department, often at great personal risk to themselves. The late Dr. Birkenhead not only kept the schools open at Liverpool and Wigan, in the face of the withdrawal of State aid, but started fresh classes at Preston. Mr. T. Jones, a gentleman connected with the Jermyn Street

* We are sorry to be compelled to condense Mr. Chapman's report, which shows that the school at Slough is truly a "technical" one.

† The falling off in the number of students in this school will be seen on reference to the table.

Museum, and simply a "Science teacher" and "student," has started classes at Bermondsey, Croydon, Greenwich, Lambeth, Marylebone, Paddington, and Woolwich, in all 30 classes, and "the teachers of these are not paid by the committees;" he pays all "expenses, in some cases a heavy rent," and fixes and receives the fees. Such gentlemen are able (no doubt from their superior education) to establish Science schools in places where they are really needed, and they are entitled to the thanks of the community.

The limited space at our disposal prevents us from giving any further information as to the condition of other schools, but when we add that at Liverpool and Wigan they have had a career precisely resembling the worst of those referred to, and have been kept open solely on account of the disinclination of teachers and committees to deprive the working-man of the means of self-improvement, we think our readers will agree with us, that the whole scheme is quite unworthy of such a country as this, and reflects little credit upon all who are concerned in its management.

That the heads of the department are alive to the fact that no persons ought to be employed in its direction except those who are initiated in Science is quite clear from the wording of that portion of the 'Directory' which gives the names of the various officials; for we find opposite several of the names of clerks and others, the expression "certificated in Science." It naturally occurred to us, as it no doubt would to our readers, to inquire what are the grades of the certificates of these gentlemen; but, unfortunately, the printed information on this subject is as scanty as it is unsatisfactory; for although the names and rank of the teachers were formerly published, we do not find them in the 'Directory' any longer.*

Amongst the "first-class clerks" there are two certificated in Science; of one we can find no mention in the list of certificated teachers in 1865, although he was then already a clerk in the department; the other has distinguished himself by taking a second-class in one section of physics only (out of twenty-three subjects in which the Committee of Council grants certificates). Of the "supplementary" clerks, three are noted as "certificated;" of two we have no means of ascertaining the grade, but a third has outstripped the "chief clerk" above referred to, for he possesses two certificates, one of the second and one of the third grade.

It would, however, be superfluous to inform our readers that the whole of this department of the State is and has been for a long time shockingly mismanaged. It has been repeated, and repeated *ad nauseam*, in the public prints, in private circles, amongst teachers and committees of schools of Science, if not of Art; but the officials

* This is no doubt owing to the fact that any one may now become a "Science teacher," who has taken a student's 1st or 2nd class prize.

have sheltered themselves behind the bales of red tape with which South Kensington is stored, and have produced each succeeding year an imposing pamphlet testifying to an increased industry in multiplying regulations for the management of a scheme which they have sought to embarrass rather than to promote.

It does not form part of our duty to point out how the system can be re-organized. That is, we presume, one of the objects for which the Parliamentary Committee is being nominated, but we hope its labours will be speedily followed by an extensive measure of reform before the best schools shall have succumbed; that a better educated class of men will be introduced into the management of the department, men fitted to make their appearance in those quarters where training-schools for Science are the most needed; that, in the name of justice and common sense, we may have a scientific man at the head of the Science department, and that if it be deemed one of the provinces of the State to encourage Science teaching, our certificated masters may be paid at least sufficient to find them in board and lodging whilst they are engaged in the public service.

II. NITRO-GLYCERINE: ITS CLAIMS AS A NEW INDUSTRIAL AGENT.

By John Mayer, F.C.S.

Notwithstanding the lamentable occurrence at Newcastle, in December last, resulting, as it did, in the death of seven persons, and notwithstanding the fact, likewise, that nitro-glycerine has in three or four instances, in America, proved itself to be a dangerous compound when not properly dealt with, its advantages as a blasting agent have been so extensively and so satisfactorily demonstrated, during the last three years or so, that it is high time that industry should more generally step in and claim it as a new handmaid which science has placed within her reach. Already on the continent of Europe, and in America, this remarkable compound has established its claim to rank in the first place as an explosive agent; and it is the object of the present article to examine in a scientific and dispassionate manner its title to be regarded in that light, in such a manner, indeed, as shall, we hope, form a marked contrast to the wild panic-stricken editorials which were so numerous in the daily and weekly newspapers during the latter half of the month of December last. There would have been less need for this present "corrective," if certain scientific journals had not also run riot immediately after the Newcastle explosion, instead of showing that their guiding minds were possessed of the spirit of true scientific

acumen and a desire to aid industrial progress in the fullest sense of that term.

It is not undesirable to refer, although very briefly, to the history and manufacture of nitro-glycerine, so as to carry our readers along with us intelligibly to the conclusion of our remarks.

Nitro-glycerine has been known as a blasting material in the operations of mining, quarrying, and railway-cutting, for about three years; but it is fully twenty years since it was discovered by a young Italian, M. Ascagne Sobrero, while he was a student in the laboratory of the well-known French chemist, Pelouze. Briefly, it may be stated that Sobrero obtained it as a result of the action of a mixture of strong nitric and sulphuric acids on glycerine. He examined it somewhat minutely, as also did several other chemists, continental and British. Amongst them Dr. J. H. Gladstone is not unworthy of mention. He reported at considerable length regarding it to the Chemical Section at the Cheltenham Meeting of the British Association.*

In course of time many facts were noted with reference to its true chemical nature and its chemical and physical properties, the chief of which, of course, was its great explosiveness, or rather its great power as an explosive compound. The practical utilization of this property was left for Mr. Alfred Nobel, a Swedish mining engineer. He was quick enough to observe that it might possibly be used in mining operations, and scientific enough to discover how it could be manufactured on the large scale, chemically pure, and always of the same quality in every respect. Former observers had been much troubled with it, owing to its instability, its tendency to decompose spontaneously, and generally with explosive violence. All chemists who know anything of the early history of gun-cotton will remember that chemical instability and spontaneous decomposition were almost invariably associated with it. Some French chemists still regard it as a very unstable, and, therefore, unsafe substance; but Von Lenk and Professor Abel have amply demonstrated that, if thoroughly cleansed raw cotton be used and every trace of acid be removed from the manufactured product, the tendency of gun-cotton to spontaneous decomposition is completely overcome. Nobel did exactly the same for nitro-glycerine, and its manufacture soon became in his hands one of the practical arts. He secured patent rights for his process of manufacture in most European states, and himself settled down on the Elbe, in the vicinity of the city of Hamburg, as a manufacturer of the new explosive, or "blasting oil," as he chose to call it.

There are now five establishments in existence—collectively aged eleven years—where nitro-glycerine is manufactured on the

* 'British Association Reports,' 1856.

large scale. They are at Lauenburg (Prussia), the one just referred to as outside the city of Hamburg, at Stockholm, Christiania, Helsingfors, and New York. In order to reduce to a minimum the danger which is alleged to attend the manufacturing operations, the establishment first mentioned is wholly built in an artificial excavation in and beneath the level of the earth; and thus any explosion which may possibly result in the works will be confined to the works themselves, and will exert no damage in a lateral direction. This plan might well be adopted in building gunpowder mills. As an indication that the manufacture of nitro-glycerine is conducted on an exact system, on rigidly scientific principles, it may be mentioned that in only one instance has there been an explosion in any of the five works mentioned, and even that was but a very slight one. The manufacture has not yet been introduced into England, although we carry on mining operations, quarrying, railway-tunnelling, &c., on such a stupendous scale as is not excelled in any country of similar extent. Why English capitalists have not taken to it we know not; but of this we feel assured, from what we know of the extent to which nitro-glycerine is already in use amongst us, that the manufacture of this substance is yet destined to become a profitable undertaking in this country, when its use will doubtless be very greatly extended.

As might almost be inferred from the name, and, indeed, as has already been mentioned, nitro-glycerine results from the action of nitric acid on glycerine; at all events, the chemistry of the operation is essentially limited to the reaction of those two substances on each other. In practice, it is found necessary to use sulphuric acid in conjunction with the nitric acid, as in the production of gun-cotton. The essential details of the chemical transformation are the following, according to M. Kopp and various other chemists:—Fuming nitric acid (sp. gr. about 1·52) is mixed with twice its weight of the strongest sulphuric acid, in a vessel which is kept cool by being surrounded with cold water. When this acid mixture is properly cooled, there is slowly poured into it rather more than one-sixth of its weight of syrupy glycerine; constant stirring is kept up during the addition of the glycerine, and the vessel containing the mixture is maintained at as low a temperature as possible by means of a surrounding of cold water, ice, or some freezing mixture. It is necessary to avoid any sensible heating of the mixture, otherwise the glycerine is to a large extent transformed into oxalic acid. When the action ceases, nitro-glycerine is produced. It forms on the surface as an oily-looking fluid, the undecomposed sulphuric acid forming the subjacent layer, owing to its greater specific gravity. The whole mixture is then poured, with constant stirring, into a large quantity of cold water, when the relative specific gravities become so altered that the nitro-glycerine subsides

and the diluted acid rises to the surface. After the separation in this manner into two layers is effected, the upper layer may be removed by the process of decantation or by means of a siphon, and the remaining nitro-glycerine is washed and re-washed with fresh water till not a trace of acid reaction is indicated by blue litmus paper. The final purifying process pursued by Mr. Nobel,* is to crystallize the nitro-glycerine from its solution in wood naphtha. Every chemist knows that by this means the substance will be chemically pure and of uniform composition and quality.

Before enlarging on the properties of nitro-glycerine and its applications, we may just glance at its chemical nature for a moment or two. Glycerine is a ternary compound, a sort of oxidized hydrocarbon, its formula in the ordinary notation being $C_6 H_8 O_6$. The combined action of the strong sulphuric and nitric acids is to transform it into a quaternary compound, a substitution product, in which three equivalents of peroxide of nitrogen ($3 NO_4$) are substituted for three equivalents of hydrogen, which are removed during the reaction. The chemical constitution of nitro-glycerine may therefore be indicated in the following manner:—

$$C_6 \left\{ \begin{matrix} H_5 \\ (NO_4)_3 \end{matrix} \right\} O_6, \text{ or } C_6 H_5 (NO_4)_3 O_6.\dagger$$

As a substitution-product, or *nitro-compound*, nitro-glycerine very much resembles gun-cotton, the *nitro-cellulose* of the chemist; indeed, it may almost be regarded as liquid gun-cotton; and certainly it has a great amount of interest for the scientific chemist, as much even as for the practical man who employs it as an industrial agent.

As prepared in the manner already mentioned, nitro-glycerine is an oily-looking liquid, of a faint yellow colour, perfectly inodorous, and possessed of a sweet, aromatic, and somewhat piquant taste. It is poisonous, small doses of it producing headache, which may also be produced if the substance is absorbed into the blood through the skin, and hence it is not desirable to allow it to remain long in contact with the skin, but rather to wash it off as soon as possible with soap and water. Glycerine has a specific gravity of about 1·25–1·26, but the nitro-glycerine has a specific gravity of almost 1·6, so that it is a heavy liquid. It is practically insoluble in water, but it readily dissolves in ether, in ordinary vinic alcohol, and in methylic alcohol or wood spirit. If it be simply exposed to contact with fire it does not explode, although it is so powerful as an

* Letter in 'The Times,' 27th December, 1867.

† Mr. Nobel regards nitro-glycerine as having the following composition (ordinary notation):—$C_6 H_5 O_3 (NO_2)_3$, and alleges, as a reason, that a solution of caustic potash will decompose the nitro-glycerine, resolving it into glycerine and nitric acid, and, with the latter, forming nitrate of potash.

explosive. A burning match may be introduced into it without producing any explosion; the match may be made to ignite the liquid, but combustion will cease as soon as the match ceases to burn. Nitro-glycerine may even be burned by means of a cotton-wick or a strip of bibulous paper, as oil from a lamp, and as harmlessly. It remains fixed and perfectly unchanged at 212° Fah.; if heated to about 360°, however, it explodes. Kopp says that it may be volatilized by a regulated heat without decomposition, but if it boils, detonation becomes imminent, and hence, when it is dropped on a metal plate which is hot enough to cause it to boil it will decompose with a somewhat violent detonation. A plate not actually red-hot will cause this change; if, however, the plate be red-hot, a drop of nitro-glycerine falling on it will immediately take fire and burn like a grain of gunpowder. At temperatures below from 43° to 45° Fah., it becomes a glassy crystalline mass, but is otherwise unchanged. It was crystallized nitro-glycerine which exploded on the Town Moor of Newcastle. Notwithstanding the great quantity of oxygen which is contained in this substance, and the powerful affinity which phosphorus and potassium have for that element, they have no effect on nitro-glycerine. If prepared perfectly pure it is totally devoid of any tendency to volatilize, and it may be kept for an indefinite period of time without showing any proneness to spontaneous decomposition.

Nitro-glycerine may be decomposed with the greatest of ease by treatment with caustic potash, which resolves it into glycerine and nitric acid. This is certainly the most effectual means of rendering it permanently harmless, although there are other substances which will bring about its decomposition without any explosion. The extraordinary power exerted by nitro-glycerine during its explosion is undoubtedly the most interesting property which this substance possesses. The practical utilization of this explosive power was at first thought impossible, because it was observed that a spark would not produce any explosion at all, and that a blow from a hammer or some similar instrument would only produce a detonation that was limited exclusively to the part struck. In using all other ordinary explosives, such as gunpowder and gun-cotton, it is practically necessary to employ fire, either as a spark or a flame, and as this would be of no use in the case of nitro-glycerine, some other mode of exploding it had to be resorted to. Mr. Nobel, who was the first person to demonstrate the possibility of using nitro-glycerine as a new industrial agent, hit upon the method now universally adopted, namely, percussion, or rather concussion. When a quantity of nitro-glycerine is spread in a thin layer over the surface of a hard stone, an anvil, or other metallic mass, and then *percussed*, or sharply struck with a hammer, only that portion actually struck explodes or detonates, so that percussion pure and simple is prac-

tically useless. The whole mass of explosive liquid must be violently *concussed*, and to produce the required concussion the nitro-glycerine must be in a confined space, while, immersed in the liquid, there must be a small bag of gunpowder, or a percussion cap of extra strength, firmly fixed on the end of a gunpowder fuse. Thus it will be seen that nitro-glycerine almost requires to be coaxed into an explosive mood; and if people could only be brought to look on the explosions at Newcastle, San Francisco, Aspinwall, and one or two other places, without prejudice, it would universally be admitted that nitro-glycerine is not only not that frightfully dangerous material which many people in their ignorance believe it to be, and which some of them in a panic-stricken mood propose to "stamp out," but that it is even less dangerous than gun-cotton and gunpowder, and more completely under control than they are. We know that this is a very heretical and unorthodox utterance, still it is one that can be most indisputably supported and established by a great accumulation of facts resulting from the observations and experience of many persons whose minds are perfectly unbiassed.

Taking advantage of the circumstance that nitro-glycerine is soluble in wood spirit or methyl-alcohol, Mr. Nobel, nearly two years ago, made the happy discovery that it could almost instantaneously be rendered inexplosive, and that its explosiveness could be restored to it with equal readiness. The method of making it inexplosive is at once simple and effective. It is to mix with it from five to ten per cent. of wood spirit, when all attempts at exploding it are rendered utterly futile. Five per cent. of methyl-alcohol is said to be amply sufficient to transform the nitro-glycerine into the inexplosive or protected state, but Mr. Nobel now always adds ten per cent. before sending any of his blasting liquid into the market. A commission, appointed by the Hamburg Association for the Promotion of Arts and Useful Professions, made an extensive series of experiments on nitro-glycerine protected by the addition of five per cent. of methyl-alcohol, in October, 1866. One of the experiments was an attempt to explode the liquid in the ordinary way with fuse and percussion cap. The experiment was twice repeated, but in neither case did the detonation of the cap affect the liquid. In another instance the protected liquid, in a tin bottle, was fired at with a bullet, but it was found impossible to produce an explosion. "In the opinion of the commissioners," the official report concludes, the protected blasting liquid "is perfectly inexplosive." When this protected liquid is exposed to heat in a proper vessel, the volatile solvent escapes, and in course of time, under the influence of a high temperature, the nitro-glycerine explodes, but not with the usual amount of violence because, probably, the explosion occurs before all the methyl-alcohol volatilizes. If protected nitro-glycerine be spread over the surface of an anvil, and then

struck with a hammer in the usual way it will not explode; after the lapse of some time, however, the explosive state is induced, owing to the evaporation of the solvent liquid.

Many interesting observations were also made on nitro-glycerine, both in the protected and explosive states, by a Royal Commission, appointed from the Engineer Corps of the Prussian army. They were made in the year 1866, at Glogau, in Silesia. One or two of the experiments may be mentioned. Protected nitro-glycerine was poured into a tin vessel, seven inches square and twelve inches high, and fired at with a breech-loading musket, from a distance of seventy feet, or thereabouts. At the first trial common, and at the second explosive, cartridges were used. When the ball struck there was no explosion in either case. "In order to ascertain its character of safety during transport, two conveyances of inexplosive nitro-glycerine were undertaken. The distance of the first tour, *viâ* Bauschwitz and Gurken, was about one German mile. The carts passed over macadamized roads, good and bad, and returned in about one hour. A tin bottle, containing $3\frac{1}{2}$ ounces of protected nitro-glycerine, was put into an old powder-box, and secured in such a manner as to admit of its moving backwards and forwards without falling down; nor was it entirely filled. The powder-box was attached to the hind axle-tree of a waggon with racks. Every pace of the horses was tried without any explosion taking place. At the second trial four horses were put to an Austrian ammunition waggon. One pound of inexplosive nitro-glycerine was put into this waggon, in a tin bottle, one-third empty, and the latter secured so as to allow it to move to and fro without falling down. This trip was somewhat longer, the cart going over about two German miles of ground. The cart was driven intentionally over the very worst parts of the road, and at the most rapid pace. On the road the bottle was inspected and was found to leak at the mouth. By this means some blasting liquid had accumulated at the bottom of the waggon, which by evaporation must have become explosive. But, as even explosive nitro-glycerine does not explode on wood, when struck ever so hard with a hammer, the trial was continued. In order to ascertain finally whether a prolonged uniform movement leads to a result different to that of violent shocks, the cart was driven from Bauschwitz to the scene of the experiments, about half a German mile, half of the road stone pavement, in a sharp but regular trot. No explosion took place."*

The transformation of protected into ordinary nitro-glycerine is effected by thoroughly agitating it with water, and allowing the mixture to settle for a short while. By this means the water dissolves out the methyl-alcohol, and the mixture of spirit and water readily rises to the surface, in virtue of its low specific gravity,

* Royal Prussian Commissioners' 'Report.'

and can be removed by means of a siphon, or, by simply pouring it off. The blasting liquid is now ready for use. It would seem that the methyl-alcohol is by this means separated very readily from the nitro-glycerine held in solution by it. If protected blasting liquid be kept in a closed vessel, it will remain in that state for an indefinite period of time, and ready at any moment to be reduced or rendered fit for action; if, however, it be exposed in an open vessel it will regain its explosiveness, in periods of time proportionate to the amount or degree of exposure. In the experiments, for instance, which were instituted by the Prussian Military Commission, it was observed that protected nitro-glycerine, exposed to the air in an open glass, only acquired explosiveness on the twenty-first day, although it was tried every second or third day; and such protected liquid, after being exposed in an open bottle with a narrow neck for twenty-one days, exhibited no tendency to explosion even then,—thus showing that comparative confinement of the liquid very greatly retards the evaporation of the solvent and protecting wood-spirit.

As an explosive capable of being practically used, nitro-glycerine is quite an exceptional substance, from the circumstance of its being a *liquid* compound. There are other liquid explosives,—as the so-called chloride of nitrogen, for instance,—but nobody has ever yet succeeded in practically applying them, or even ventured to prepare any of them in large quantity. The force exerted by nitro-glycerine, during an explosion, is truly marvellous; indeed, no correct conception can be formed of it by any person who has not himself experimented with it, or has, at all events, seen the experiments performed. Weight for weight the new explosive is ten times more powerful than gunpowder. The extraordinary mechanical or eruptive power which it exerts is partly owing to the fact that there is no solid residue attending the explosion, and that the enormous pressure exerted by the resulting gases is due to the great rapidity of the explosion. The rocks being blasted have not time enough permitted them to effect any sensible cooling and condensing of the vapours. In fissured rocks this rapidity of explosion is of immense consequence; it is so very great that the tamping employed in blasting operations, is in many cases not ejected from the bore-holes, although—by preference—it is almost invariably quite loose, consisting of sand, slate-dust, or other finely-divided solid matter, or even ordinary water.

Hard tamping is of comparatively little use, owing to another very curious property possessed by nitro-glycerine, namely, that of "striking down," as it has been called, or of exerting its explosive force—unlike gunpowder—almost entirely in a downward direction. This circumstance is intimately connected with the explosion on board, and ultimate destruction of, the steamship 'European'

at Aspinwall. The nitro-glycerine taken by that vessel from Liverpool was placed in the very bottom of the hold, owing to its being shipped as a liquid. There is not room here to discuss all the *pros* and *cons* of that catastrophe; but one or two facts may be mentioned, as they have great scientific and practical interest, and some of them, although brought out at the Liverpool trial last summer and made public, have been misinterpreted. It is known that, besides the seventy-two 28lb. cases of nitro-glycerine, there were some 20,000 percussion caps and other combustible substances on board. It is also known that there were three explosions, the first being very loud and occurring about twenty minutes before the second, which was not nearly so loud, and the third and last occurring *after the vessel had taken fire* and had been for some time out at sea, where she had been towed by another steamer, and where she continued to burn, and eventually went down. The nitro-glycerine confined in the hold of a large iron steamer in such a warm climate would necessarily be in a somewhat sensitive state. The spontaneous combustion theory set up at the Liverpool trial, and supported by Professors Abel and Roscoe, is not necessary to account for the results. The first explosion was certainly due to nitro-glycerine, a case of which was being hoisted up by a steam-crane, and with such rapidity that when near the deck it struck against a beam and immediately exploded, when it was observed that two iron plates were blown off the top of the vessel on the port side and near the stern. There seems to be no room for doubting that the last explosion was also caused by nitro-glycerine, when the loudness of that explosion—it was louder than the second—is borne in mind, as also the intense heat of the burning ship, the position occupied by the remaining seventy-one cases of the liquid, the "striking down" character of an explosion of nitro-glycerine, and the fact that the said explosion caused the ship to go down. That it did not seem so loud as the first explosion is accounted for by the circumstance that the ship was not then lying at the wharf, but was some distance out at sea, and by the fact, also, that the nitro-glycerine was at the very bottom of the hold, at least ten or fifteen feet below the surface of the water.

Had we space at command it would be profitable to discuss the facts and suppositions connected with the Newcastle explosion, as that occurrence is invested with a great amount of interest. The evidence at the coroner's inquest—as at the Liverpool trial—brought forth the usual theory of spontaneous decomposition, supported by the stock arguments. As we happen to know something of the history of the Newcastle nitro-glycerine, we may oppose a few facts to the fiction which the Newcastle Coroner was compelled to listen to. To do so may possibly disabuse the minds of some persons of the prejudices acquired by the untoward event of December last. The

nitro-glycerine in question was manufactured at Hamburg in the usual way, mixed with methyl-alcohol, and shipped as inexplosive blasting liquid, at the commencement of the winter 1866–7, on board a vessel which, on account of an accident, had to put into Harwich, where the cargo was received into two lighters, and remained about two months exposed to the severest weather of the season. One of the cases was opened at Harwich, in order to get a sample, but that was found to be an impossibility, as the contained nitro-glycerine was a perfectly solid ice-like mass. The weather had apparently destroyed the effect of the methyl-alcohol. When the substance was conveyed to Carnarvon, part of it was washed with water in the usual way, to remove the alcohol, as if it were still protected. But that was found to be unnecessary. The slate-quarrymen fired it with gunpowder without any difficulty, and it was evident that the effect of the alcohol, if not entirely destroyed, was nearly so. Twenty-four of the cases—6 cwt.—were sent into the Newcastle district in July last. A large portion of it, as is now well known, was stored in the town of Newcastle, in contravention of the provisions of the "Carriage and Deposit of Dangerous Goods Act, 1866." At the fatal Town Moor three of the tin cases, the tops of which were strongly soldered down, were forcibly opened by means of a spade, and found to contain a quantity of solid nitro-glycerine. In this state practical men know it to be more difficult to explode than when in the liquid state; but that it resisted such violent treatment is almost inconceivable, and that Sub-Inspector Wallace is still living is little short of a miracle. Is it possible that any sane person can believe that the crystallized nitro-glycerine after such a rough career and such violent usage could explode spontaneously? that it was so sensitive that the simple slipping or friction of one piece upon another brought about the fatal explosion? We sincerely hope not.

That nitro-glycerine has properties of peculiar value in blasting operations may be inferred from the following facts:—

The first and most successful company formed for the manufacture of the substance is one formed at Stockholm towards the end of the year 1864, and the shareholders in which are *all Swedish miners*, with the exception of one who is the director of the Stockholm Private Bank. The shares are much in request, but they are not in the market, and cannot be had, and the dividends are greater than the directors care to tell. The rapidity with which the Swedish miners took to the use of the new blasting agent is most extraordinary. The great tunnel of the Central Railway through Stockholm was blasted throughout with nitro-glycerine made by that company. A stupid accident occurred—not an explosion of the blasting liquid—which frightened the authorities so much that a royal order was issued that no more than two pounds of nitro-

glycerine should be stored in one place within the city; but the workmen declared, one and all, that they would resign rather than work again with gunpowder for the same pay. For a few days the royal order remained in force, but it was then cancelled by dint of necessity, and the work of the tunnel proceeded to completion—the greatest underground work executed by the new blasting agent. Mr. Eric Unge, the chief engineer and managing director, speaks very highly of the advantages of using nitro-glycerine, including amongst them the saving of 23 per cent. on the cost of blasting, and 87 per cent. greater speed than with the use of gunpowder.

In the largest slate quarries of North Wales—some of them of immense extent—a larger amount of money is spent yearly on nitro-glycerine than on gunpowder for blasting purposes; and in many cases the men make their bargains dependent on the quarry proprietors undertaking to guarantee a supply of nitro-glycerine. Tons of this substance are used annually in the Welsh slate quarries, and yet accidents from its use, or rather its abuse, are almost never heard of. At the Penrhyn and Dinorwic quarries one quarter of a ton per month is used. Mr. Parry, the manager of the Dinorwic quarries, was recently asked about the danger of using nitro-glycerine as a blasting agent. He said they had never had an accident with it, while the accidents from gunpowder were so numerous during the past year, that he really could not tell how many there had been.

These are only samples of scores of facts which might be quoted in respect of the safety, the remarkable properties, and extensive use now attained by nitro-glycerine. In concluding, we may use the language of one of our correspondents who favours us with his experience as a practical man. He says:—"Miners may have dreamed of a blasting material ten times as strong as gunpowder, exploding with such velocity as to need no tamping, unaffected by water, blasting seamy as well as the hardest and most solid rock, and leaving no smoke; but surely in this substance the very properties most needed are realized to such an extent as to appear utopian or extravagant to all those who have not tried it for themselves. Whatever its drawbacks may be, nitro-glycerine certainly deserves a fair and liberal investigation. Nature and science have placed at our command one of the most powerful agents ever sent forth from their united laboratory; neighbouring nations have learned to tame its somewhat rebellious nature, and why should not we follow the example which they have set us?"

III. RANSOME'S PATENT CONCRETE STONE.

By Fred. Chas. Danvers, A.I.C.E., M.S.E.

Amongst the numerous inventions of the present age, we find but few aiming at an imitation of the works of Nature in so early an era as that which bears date long prior to the creation of man. With the advancement of scientific research, the aid of chemistry is now more generally sought than formerly, with a view to the creation or production of articles of general use, or to assist in the preparation and manufacture of some of our leading staple productions. Who, fifty years ago, would have thought of attempting the manufacture of stone? although many alchemists have in earlier days worn out their existence in the attempt to manufacture diamonds and gold. Yet now we see the art of man rivalling in its productions some of the supposed earliest strata of our globe, and the manufactured sandstone of the present day has been found by experiment to be superior to that obtainable in the best known quarries. Manufactured by the aid of chemistry, that agency has also itself been used to test its endurance, and the results show that, so far as can be ascertained by such means, the patent concrete stone is likely to endure far longer, when used in buildings or for other purposes to which it may be applied, than any of our natural sandstones; and we cannot but feel a conviction that not only will the invention of Mr. Frederick Ransome shortly lead to a considerable convulsion in the building trades, but that it will prove also a stepping-stone to other inventions of scarcely less importance and usefulness.

Mr. Ransome formerly belonged to the well-known engineering firm of that name at Ipswich, and it was whilst connected with them, and so long back as the year 1844, that his attention was first drawn to the subject of artificial stone. During the manufacture of some flour-mills for one of the colonies, Mr. Ransome's attention was directed to the unequal hardness of certain portions of a burr-stone when overlooking a workman renewing its worn-out ridges. It occurred to him that much time might be saved, and greater economy of working secured, if a stone of uniform grit could be obtained which would wear away evenly upon its surface. Collecting in his hand some of the surrounding chips, the idea suddenly suggested itself to his mind that some suitable means of cementing them together only was required in order to produce a stone of uniform hardness throughout. The first agency employed for this purpose was plaster of Paris, but this failing to give the desired results, he subsequently employed every other known material likely to act as a cement, during which experiments, though un-

successful, he succeeded in obtaining a vast amount of excessively useful information regarding the properties of those several material in their varied conditions.

Notwithstanding his repeated failures, Mr. Ransome took out a patent for a process of making artificial stone, being confident that in the six months, at the end of which he would have to file a complete specification, he would be able to discover some means of attaining his desired object.

The next experiments were with the use of pulverized glass which he mixed with the sand. The mixture was first subjected to hydraulic pressure in iron moulds, and then by the application of heat the glass was fused and the particles were consequently mixed together. This plan, however, also failed, owing to the stone either breaking or running into vitrified masses when subjected to the high temperature of the kiln. The idea of obtaining liquid glass and mixing it with the sand next occurred to his mind, and this was within three weeks of the time when the final specification had to be lodged at the Patent Office.

Mr. Ransome's attention having been drawn to the solution called silicate of soda, determined to make further experiments, with a view of testing its applicability to furnish the sort of cement he so much desired. "Flint, although apparently a most inert substance, is, in its chemical constitution, as much an acid as sulphuric acid is. In the one case we have one atom of silica combined with three atoms of oxygen, and the other, also, one atom of the base—sulphur—combined with the same number of atoms of oxygen. Using the ordinary chemical symbols, flint is, $Si\text{-}O^3$; sulphuric acid, $S\,O^3$. Now it is found that just as sulphuric acid combines with potash or soda to form a salt, so does silicic acid combine with either of these alkalies. The difference between the reactions is, that in the case of sulphuric acid, the affinity for the alkalies is more energetic, and the union takes place more rapidly and at a lower temperature. There are two methods of combining potash or soda with flint. The first, called the dry process, is to take a quantity of fine sand, which is nearly pure silex, and to mix it in a crucible with an excess of the alkali, and then to bring the whole mass to a high temperature, when a combination readily takes place. If the quantity of alkali used is just sufficient to saturate the silicic acid—that is, if there is only one particle of the alkali to one particle of the acid, as represented in the formula $K\,O, Si\,O^3$, the glass so formed is less soluble in water than when there is an excess of alkali, as in the formula $^3K\,O, Si\,O^3$. This process is necessarily an expensive one, for two reasons—the large quantity of alkali which is required, and the high temperature rendered necessary to effect the combination.

"The other, or moist process, although not liable to the last

objection, is, nevertheless, more open to the first. In the moist process calcined flints were ground to a fine powder, and then mingled with a large excess of alkali, either potash or soda; and this mixture boiled for a considerable length of time, when a thin, rather sweetish fluid formed, which was a solution of silicate of soda, when that alkali was used. As already stated, the disadvantages attending this process are the large excess of alkali which it requires, the tediousness of the operation, thinness of the solution, and lastly, the expense of calcining and pulverizing the flints."*

The great desideratum now was to devise some method whereby a solution of silicate of soda might be obtained of sufficient consistency for his purpose, and at such a price as to render it available for general use. Whilst lying in bed one night, the idea suddenly flashed across his mind that if he subjected flint-stones in a solution of caustic alkali to heat in a boiler under high pressure, he might be able to reduce them to the desired state. Forcibly impressed with the idea that he had at last hit upon the right means to his end, he jumped out of bed, and having called his laboratory boy to his assistance, he took an old boiler belonging to a model steam-engine, and having fitted on to it a safety valve and a small cock whereby to draw off the liquid at intervals to test it, he filled the boiler with flints and a small quantity of caustic soda and water. He now urged the fire, and from time to time drew off small quantities of the liquid, which, in spite of all endeavours, continued as thin as at first. The pressure, perhaps, was not sufficient, so he tied down the safety valve, and continued to urge the fire until, to his dismay, the boiler began to get red-hot. Thinking now that his experiment was at an end—that all the liquid in the boiler had evaporated, and probably nothing remained within it but the hard flint-stones as they had at first been placed there—he began to yield to despair, for but a short time yet remained before he must file his complete specification. Taking hold of the boiler with a long pair of tongs, he threw it into a cistern of water which stood close by, and, as might have been expected, the boiler at once flew to pieces. Desirous now of obtaining some rest after the toil and excitement of the preceding hours, he was going into the house to retire again to bed, when, on passing the cistern, he looked in upon the fragments of the boiler, which, to his astonishment, were coated internally with a white waxy substance, and at the bottom of the cistern lay a glassy syrupy mass. On trying to separate this hard substance from the shell of the boiler he found that the part of it in immediate contact with the iron was hard as the natural flint from which it had been made. Thus then, when on the brink of despair at the supposed failure of his endeavours, Mr. Ransome discovered that, not only could he reduce his flints to an almost liquid consistency,

* 'The Engineer,' December 5, 1856.

but that the means also existed of restoring those disintegrated particles to their former consistency and hardness. Thus far Mr. Ransome had succeeded in dissolving his flints, but he found, on mixing his silicate of soda with sand in moulds, that the application of heat for the purpose of reindurating the silica failed to give satisfactory results, for the surface first naturally became hard and was cracked by the escape of the moisture from within.

The desired end was therefore not yet attained, but Mr. Ransome persevered in his experiments, and seemed gradually approaching towards more satisfactory results, when, about the year 1852, the discovery that the stones with which the Houses of Parliament at Westminster had been built, were beginning to show signs of decay, caused his attention to be directed to the discovery of some means whereby his solution of silicate of soda could be applied, so as to give an indestructible surface to the stonework. "He had not proceeded far in the application of soluble silicates to this purpose before he found that, although the theory with which he started was alike pretty and plausible, in practice the results were imperfect, inasmuch as the substance applied as a preservative being in itself soluble, the ordinary humidity of the atmosphere, apart even from the more powerful action of showers of rain, would, at least partially, dissolve and wash it away. Mr. Ransome's numerous experiments at this juncture, about 1856, were directed to the discovery of means for converting the soluble into an insoluble silicate, so as to render the effect perfectly independent of extraneous action and conditions. It occurred to him that if a compound silicate of lime—the substance which has given such enduring properties to the old mortars of the ancients, which have remained unchanged for thousands of years—could be formed in the structure of the stone, that agent would not only possess the property of perfect insolubility, but it would also most effectually envelop and bind firmly together, by an indissoluble bond, the several particles of which the stone is composed. After numerous experiments, designed to reduce this principle to practice, he found that the application of a solution of chloride of calcium (or lime dissolved in muriatic acid) formed, almost instantaneously, with the silicate of soda previously used, by double decomposition, an insoluble silicate of lime, and a soluble salt of chloride of sodium, or common salt, which latter substance is easily removed by subsequent washings."* Subsequent experiments having proved the readiness with which this principle might be applied to the preservation of natural stones from decay, Mr. Ransome next turned his attention to the manufacture of stone by the same process. The results proved as satisfactory as could be desired, and in 1863 a joint stock company was formed with a view to carry out operations on a large scale.

* 'Engineering,' December 7, 1866.

Works have now been erected at East Greenwich, having a frontage on the river, and although not yet to the extent contemplated, they even now cover a large area, and will repay a journey from town in order to inspect them. The process of the manufacture of this artificial stone is exceedingly simple; the sand, chalk, or other mineral substance, is mixed with its proper proportion of a solution of silicate of soda in an ordinary pug-mill, and the mixture, which very much resembles in substance fresh putty rolled in sand, and is of a very plastic consistence, is either pressed into blocks or moulds, or can be rolled into slabs or forms as may be desired, and is afterwards either saturated with, or immersed in, a solution of chloride of calcium, when a double decomposition of the two solutions employed immediately takes place. The silica combines with the calcium, and at once forms an insoluble silicate of lime, firmly binding together all the particles of which the stone is composed, whilst at the same time the chlorine combines with the soda and forms chloride of sodium, or common salt, which is easily removed, as has been already explained. The materials used by the Patent Concrete Stone Company at their works at East Greenwich are principally sand, gravel, flints, chalk, limestone, caustic soda, chloride of calcium, and water. Any quantity of the finest sand is obtainable from the neighbourhood of Maidstone; gravel is to be had at a nominal price from the bed of the Thames; chalk and flints are abundant in the numerous pits near by; the chemicals are brought by water carriage from the North of England, and a plentiful supply of water is furnished by a large well which has been sunk in the yard, this supply being supplemented, as required, by the North Kent Water Company.

The digesters, in which the silicate of soda is produced, are supplied with steam from a high-pressure boiler. In the lower part of each digester is a coil of steam-pipe, and above this is an iron grating upon which the flints are placed. The digester is then nearly filled with a solution of caustic soda, of a specific gravity of about 1·120, and the steam is admitted into the coil pipe raising the liquid to boiling point. When this operation has been continued long enough the liquid solution is sent into a reservoir, whence it is drawn off, from time to time, into pans, in which it is evaporated down to a specific gravity of about 1·700; this gives the necessary degree of viscidity for the use to which it is to be applied.

The best stones are made from finely sifted dry sand. A small quantity of pulverized stone, or carbonate of lime, is added to the sand to give the silicate of lime, produced in the manufacture, the necessary closeness of surface for its cementing action. To each bushel of this mixture, one gallon of the silicate of soda, prepared in the manner stated above, is added; they are then thoroughly incorporated together in a mill, which operation takes only about

four minutes. The plastic mass is then put into moulds, and rammed firmly into the corners and interstices by means of wooden instruments designed for the purpose. When turned out of the moulds the edges all present a very sharp rigid appearance, and in the further process to which they are subjected, the mouldings retain their precise form and size without either shrinking or cracking. After being turned out of the moulds, they are played upon with a solution of chloride of calcium in a cold state, which speedily solidifies the mass. The castings are next immersed into a bath containing a solution of chloride of calcium, having a specific gravity of about 1·400, and a temperature of about 212°. After this operation it only remains to wash away the chloride of sodium, which is readily effected by placing the stone under a dripping shower-bath. This done, the stone is ready for any purpose for which it may be designed.

The following is an extract from a report by Dr. Edward Frankland, F.R.S., &c., Professor of Chemistry at the Royal Institution, London, dated December 21st, 1861:—

"I have submitted to experimental investigation the samples of stone forwarded to this laboratory, and have now to report as follows:—The experiments were made in the following manner. The samples were cut as nearly as possible of the same size and shape, and were well brushed with a hard brush. Each sample was then thoroughly dried at 212°, weighed, partially immersed in water until saturated, and again weighed; the porosity or absorptive power of the stone was thus determined. It was then suspended for forty-eight hours in a very large volume of each of the following acid solutions, the alteration in weight after each immersion being separately estimated. The sample was then boiled with water until all acid was removed and again weighed. Finally it was dried at 212°, brushed with a hard brush, and the total degradation or loss since the first brushing was ascertained. The following numbers were obtained:—

Name of Stone.	Porosity: Percentage of water absorbed by dry stone.	Percentage alteration in weight by immersion in dilute acid.						Total Percentage loss by action of acid and subsequent boiling in water.	Further loss by brushing.	Total degradation from all causes.
		Of 1 per cent. Acid.		Of 2 per cent. Acid.		Of 4 per cent. Acid.				
		Loss.	Gain.	Loss.	Gain.	Loss.	Gain.			
Bath	11·57	1·28	—	2·82	—	2·05	—	5·91	·26	6·17
Caen	9·86	2·13	—	4·80	—	·67	—	11·73	1·60	13·33
Aubigny	4·15	1·18	—	4·00	—	—	1·04	3·56	·29	3·85
Portland	8·86	1·60	—	1·10	—	1·35	—	3·94	·24	4·18
Anston	6·09	3·52	—	3·39	—	3·11	—	11·11	·27	11·38
Whitby	8·41	1·07	—	—	·53	None.	None.	1·25	·18	1·43
Hare Hill	4·31	·75	—	—	·60	None.	None.	·98	·15	1·13
Park Spring	4·15	·71	—	—	·10	·15	—	·81	None.	·81
Ransome's Patent	6·53	—	·95	None.	None.	None.	None.	·63	·31	·94

The numbers in the above table speak for themselves, and it is scarcely necessary for me to add that whilst they point out the Portland, Whitby, Hare Hill, and Park Spring, as the natural stones best adapted to withstand the influences of town atmospheres, they also indicate that Ransome's Patent Concrete will be found equal to the best of these, and if the newness of Ransome's stone (the specimen experimented upon not having been made a fortnight) be taken into consideration, together with the well-known fact that its binding material, silicate of lime, becomes harder, and more crystalline by age, I am induced to believe that Mr. Ransome has invented a material which, with the exception of the primary rocks, is better capable of giving permanency to external architectural decorations than any stone hitherto used."

A very interesting set of experiments was made so recently as January last, with a view to test the transverse strength of the patent stone. For this purpose bars of selected samples were obtained of Bath Stone, Park Spring, Bramley Fall, and Portland, which were set in competition with Ransome's Patent Stone. The bars were each four inches square in sectional area, and two feet long; they were supported upon iron bearings, each of one inch in width, and placed seventeen inches apart in the clear. The bars were then weighted in the centre by weights suspended in an iron strap, having a bearing on the samples of one inch in width. The Bath Stone broke immediately with a weight of 942 lbs., Park Spring with 1,495 lbs., Bramley Fall with 2,091 lbs., and Portland with 2,132 lbs., whilst Ransome's Patent Stone sustained a permanent weight of 2,153 lbs. without fracture.

Besides stone for ordinary building purposes, Mr. Ransome also manufactures grindstones from the same materials. One great advantage of these artificial grindstones is that they can be made with any degree of fineness and sharpness of grit, whilst their cost is not greater than that of natural stones. At some experiments recently made by Messrs. Donkin and Co. of Bermondsey, the following remarkable results were obtained:—A Newcastle stone, and one of Ransome's manufacture, were both set up and driven by a belt from a driving shaft, whilst a bar of steel was fixed and pressed against each revolving stone by means of a spiral spring. The time taken to grind away one ounce of steel was, by Ransome's artificial grindstone, sixteen minutes, and by the Newcastle stone, eleven hours, and that notwithstanding the surface speed of the latter was more than 20 per cent. greater than of the former.

By omitting to mix the pulverized stone or carbonate of lime with the sand for manufacturing stone for ordinary uses, as has been already described, a porous stone is obtained suited for filtering purposes.

It is impossible to state to what new applications this process

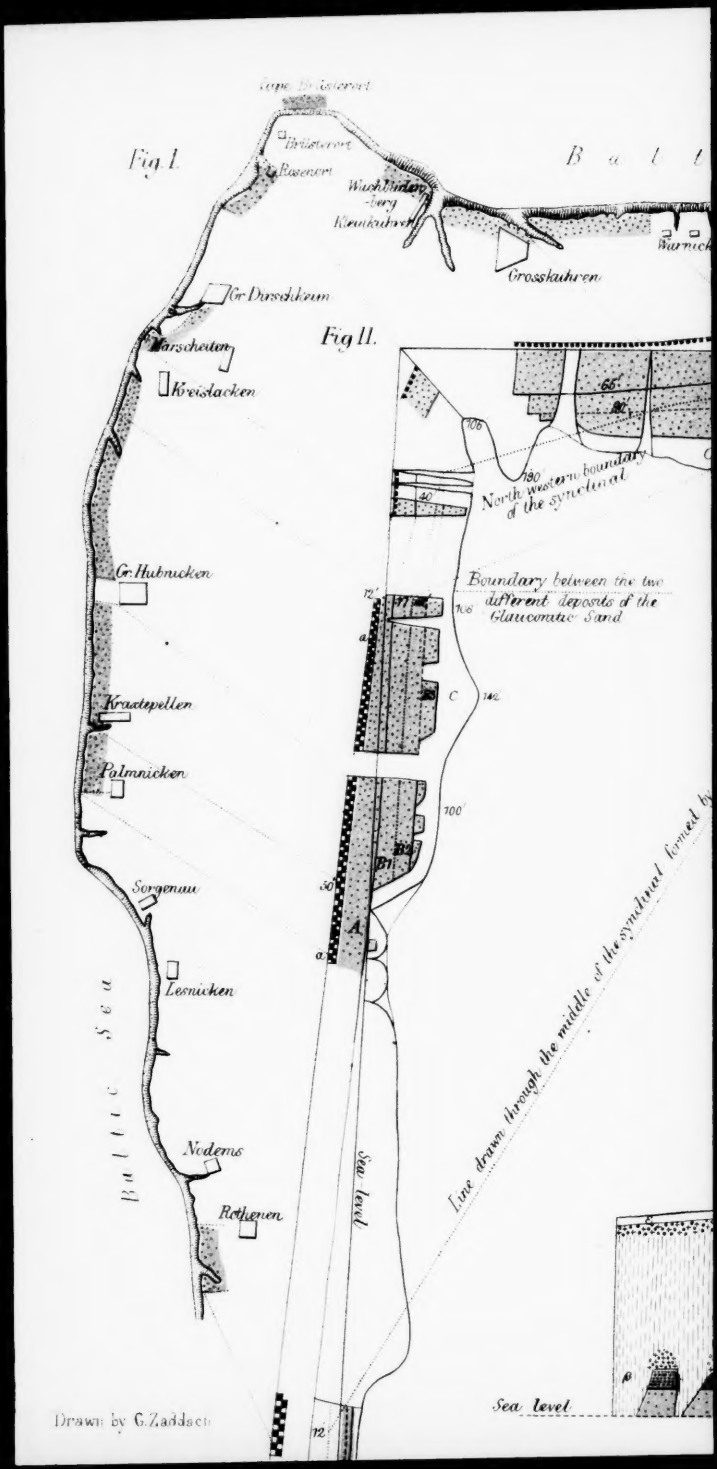
Fig I.
Fig II.
Cape Brüsterort
Brüsterort
Rosenort
Washhuben-berg
Kreuzkuhren
Grosskuhren
Gr. Dirschkeim
Marscheiten
Kreislacken
Gr. Hubnicken
Kraxtepellen
Palmnicken
Sorgenau
Lesnicken
Nodems
Rothenen
Baltic Sea
North western boundary of the synclinal
Boundary between the two different deposits of the Glauconitic Sand
Sea level
Line drawn through the middle of the synclinal formed by
Drawn by G. Zaddach

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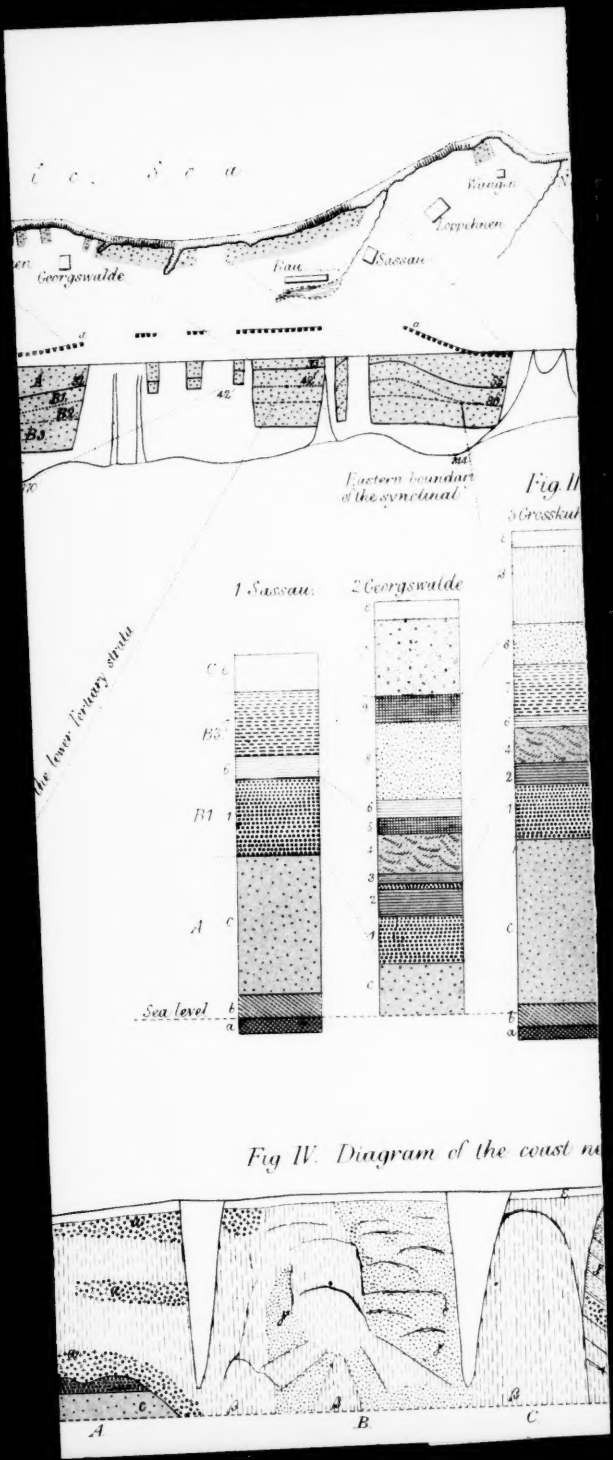

Fig IV. Diagram of the coast n

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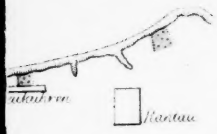
MAP
OF THE
NORTH WEST COAST
OF
SAMLAND.



I. Sections of the coast near
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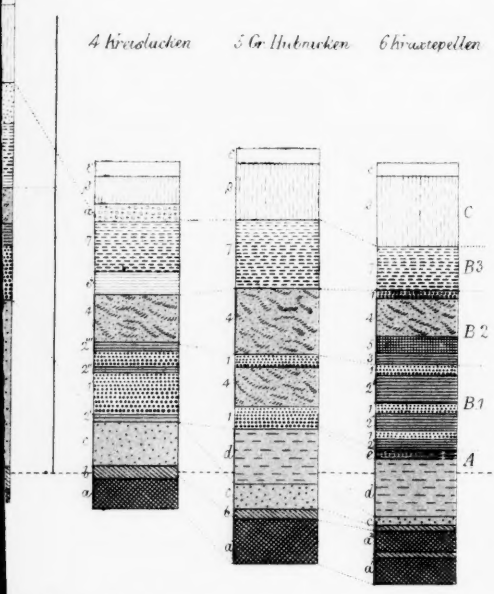
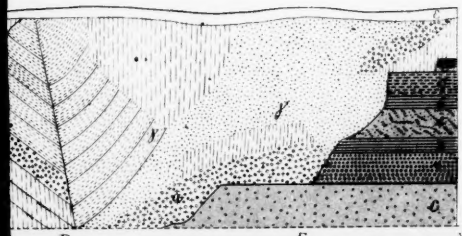


ar Warnicken



Upper-Diluvium

Sand of Lower Diluvium

Marl of Lower Diluvium

Gravel and erratic blocks

Brown-coal

Micaceous Sand

Striped Sand

Clay or sand mixed with clay

Quartz sand and coal-sand

Glauconitic Sand

e Green and d White Mail

Green Sand

a Quicksand and a Amber earth

Glauconitic Sand

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of manufacturing artificial stone may, with certain modifications, be found capable of being adapted. It is now used extensively in England and all over the Continent, as well as in America, where amongst other buildings it has been extensively used in the decorative portions of Cranston's Hotel in New York. It is being employed in the construction of a glass roof over the beautiful Indian Court at the new India Offices in London, and a great quantity of ornamental work has been sent out by the Patent Concrete Stone Company for public buildings under construction in Calcutta. They have received orders also from China; and large quantities of the silicate of soda and chloride of calcium have from time to time been shipped for different parts of India, with the view of manufacturing artificial stone on the spot where it was required to be employed.

IV. AMBER; ITS ORIGIN AND HISTORY, AS ILLUSTRATED BY THE GEOLOGY OF SAMLAND.

By Dr. G. Zaddach, Professor in the University of Königsberg, and Director of the University Museum.

The Natural History of Amber still presents its many problems, although for the last century numerous investigators have endeavoured to solve them. One of the few places at which some of these questions may be elucidated is Samland, which has for ages been celebrated for its richness in Amber, and which even now possesses in deep-seated deposits an inexhaustible store of this valuable fossil. I therefore undertook, some years ago, the geological examination of this district in the employment of the 'Physikalisch-ökonomische Gesellschaft' of Königsberg, and I have lately published the results of my survey in a detailed essay, accompanied by several maps, in the 'Schriften' of that body. A short summary of these results will, I hope, be of some interest to the readers of this Journal.

By the name Samland is distinguished that part of the Province of Prussia which is bounded on the west by the Baltic; on the north by the same sea, the Kurische Nehrung, and the Kurische Haff; on the east, by an arm of the Pregel (the Deime); and on the south, by the Pregel itself and the Frische Haff. The north-west part of this region, which constitutes the promontory of Brüsterort, is hilly, from 100 to 150 feet in height on the average, but reaching in many places to the height of 200 feet, and in some even to 300 feet. On the other hand it becomes flat towards the north-east and east, and gradually sinks down towards the south-eastern angle, where, upon a peninsula lying between the sea and

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the Frische Haff, are situated the seaport and the fortress of Pillau. This surface-contour of the country corresponds also with the form of the coast, the eastern portion of the north coast and the southern portion of the west coast being for the most part flat, and exhibiting only Quaternary formations: Diluvium, and Alluvium. The coast of the elevated north-western portion of the country, on the contrary, forms steep cliffs both on the north and on the west, and exhibits a section from 100 to 190 feet in height. In this manner an excellent insight into the geological structure is afforded, showing that in many places, under a proportionally slight thickness of Diluvium, Tertiary beds are conspicuous at a height of from 80 to 125 feet above the sea-level. They are not continuous, but are interrupted at several places, the gaps being filled up with newer formations, such as marl and sand. Sometimes also dislocations are seen in the older deposits, while the Tertiary beds are broken through and displaced by the pressure of the overlying masses.

Fig. I. in the accompanying quarto plate shows the north-western part of the coast of Samland on a scale of 1 : 100,000. Below it is drawn a view of the profile of the same part of the coast, where the vertical scale is 36 times that of the horizontal. The notches reaching from the surface to the sea-level signify ravines, which at various places intersect the coast, and down which streams flowed to the sea. The heights are given in Prussian duodecimal feet. The places where the Tertiary formation is preserved are shaded both upon the map and section: the white portions are therefore those where only Postpliocene or Diluvial masses exist. Of the formations which belong to the recent period, there occurs on this coast only blown sand, or Dunes, and these in so slight a degree as to require no attention.

Where the Tertiary formation crops out it always comprises two different deposits; the underlying consisting of thick beds of Glauconitic Sand, which sometimes attains a height of 65 feet above the sea-level (Figs. II., III., *A*), and upon which are the beds of the Brown-coal formation, from 60 to 100 feet thick (*B*).

The Glauconitic Sand is not everywhere similarly composed. It is necessary to distinguish a northern deposit, which occurs on the whole of the north coast, and on the northern part of the west coast, as far as the village of Kreislacken; and a southern deposit, which extends from Kreislacken to the village of Kraxtepellen, so far as the formations can generally be followed on the coast.

The northern deposit (Fig. III., 1, 2, 3, *A*) is very simply constituted. The upper part, from 40 to 60 feet thick, presents a bright-green sand (*c*), which is composed of rather large quartz-grains and bright-green knob-like granules of Glauconite. In the north-western corner of Samland, namely, near the villages of Grosskuhren, Kleinkuhren, and Rosenort, the lower beds of this

"Green Sand" are cemented by hydrated oxide of iron into a coarse sandstone, which is important on account of its containing remains of numerous animals, which have not been preserved in the loose sand. Under the "Green Sand" lies a deposit, consisting of finer quartz-grains and a larger quantity of Glauconite, besides containing clay and Mica, which increase in quantity the deeper the deposit is penetrated. The Glauconite gives it, in the dry state, a greyish-green colour, which becomes nearly black when the rock is moist. Generally, also, the following beds can be distinguished in this deposit. The uppermost, from 5 to 8 feet thick, is called a "Quicksand" (Fig. III. *b*), because it contains a large quantity of water, which has been arrested in its descent by the underlying clayey stratum; next follows the so-called "Blue Earth," or "Amber-earth," which is from 3 to 4 feet thick, and more firm, dry, fine-grained, and argillaceous than the "Quicksand." The still more deeply seated deposit is called the "Wilde Erde," because it contains no Amber. It has been explored only here and there to the depth of from 10 to 18 feet; and generally there has been no inducement to penetrate farther. It is also unknown how deep this formation continues and what underlies it.

The Amber occupies only a narrow zone in the whole formation; in this, indeed, it occurs abundantly, but is not equally distributed. For each square foot of the surface of the bed, that is, one cubic foot of sand, from $\frac{1}{2}$ lb. to 1 lb. of Amber may be reckoned as about the average. The pieces are of various sizes, those weighing as much as half-a-pound being seldom found; and larger lumps of one or more pounds weight are extremely rare. Their surfaces are dull and worn, and their edges and angles are also somewhat rounded, but not to a sufficient extent to obliterate the various forms which they originally received as the liquid resin of a tree, such as pins, drops, and plates, which were formed between the bark and the wood, or between the yearly rings of growth of the stem. Frequently, also, fine impressions of the parts of the plants which produced them can be distinguished on their surfaces. It follows, therefore, that the pieces of Amber were for some time, but not for very long, rolled about by the water previous to their deposition.

With the Amber also occurs fossil wood, but generally only in small pieces, which were probably half-decayed when they were deposited. The complete stem of a tree has never yet been found in the Amber-earth, and solid pieces of a foot or more in length are very rare. Such pieces of wood as still have Amber attached to them are of especial interest; and there are even some so completely penetrated with Amber-resin that they appear to consist not so much of wood-fibres as of Amber-filaments. In the "Amber-earth" and in the lower part of the "Quicksand," there also occur pieces of compact clay and marl, which contain numerous fossils, the same

as those which are found in the overlying ferruginous sandstone. Mr. C. Mayer, of Zurich, determined thirty-five species of these fossils in the year 1860.* Among them the most abundant are an oyster (*Ostrea ventilabrum*, Goldf.), a small cockle (*Cardium vulgatissimum*, Mayer), *Pectunculus polyodontus*, Phil., *Natica Nysti*, D'Orb., *Morchia Nysti*, Gal, besides two species of *Spatangus* (*S. Sambiensis*, Beyr., and *S. bigibbus*, Beyr.), a small *Echinus* and a *Scutella* (*S. Germanica*, Beyr.); as well as a Crab related to the living *Carcinus moenas*; finally, there occurred in the greatest abundance species of *Eschara* and *Cellepora*.

The conclusion which Mr. Mayer has drawn from his examination is that the "Glauconitic Sand" of Samland is of the same age as the Glauconitic Sand of Egeln near Magdeburg, and of Lethen in Belgium, and therefore belongs to the Eocene or Lower Oligocene division of the Tertiary formation.

From the circumstances previously mentioned it follows that the Amber in the "Amber-earth" by no means lies in its original bed, that is, not in the soil of the old forest in which the Amber-pines grew; but that the whole deposit of the "Glauconitic Sand," so far as we have hitherto considered it, is a marine formation; and that the Amber was washed into it by the sea in which the crabs, sea-urchins, and oysters lived. From the habits of these animals, and from the form of the pieces of Amber, it may be inferred that the deposition of the latter occurred not very far from the shore; and from the condition of the Amber, that its deposition took place in a proportionately short time, and that considerable stores of it must have been collected in neighbouring localities. In the beds above and below the "Amber-earth" only a few isolated pieces of Amber occur.

The southern deposit of the "Glauconitic Sand," which commences near the village of Kreislacken on the west coast (Fig. III., 4, 5, 6*A*), behaves somewhat differently. Here the distance between the base of the "Amber-earth" and the upper margin of the "Green Sand" is less than anywhere else, namely, scarcely 30 feet, notwithstanding that the "Amber-earth" is 8 feet thick. Towards the south, however, the latter not only descends lower, but also increases in thickness, so that in a distance of half a German mile, near the village of Kraxtepellen, the thickness of the formation has increased to more than 50 feet, and that of the "Amber-earth" to more than 20 feet. This is caused by the coming in here of five different beds above one another from south to north. The Amber-earth is here composed of two different layers (Fig. III., 6, a^1, a^2), each of which is covered with a bed of quicksand, and the lower of which is dis-

* 'Die Faunula des marinen Sandsteines in Kleinkuhren bei Königsberg.' Vierteljahresschrift der naturforchenden Gesellschaft in Zurich. Jahrg. 1861, p. 109.

tinguished by its very coarse quartz grains. Above them lies a bed of "Green Sand" (*c*), then follows a bed composed of a very fine micaceous sand, from 10 to 25 feet thick, containing quite as small granules of glauconite, and much clay, being near the latter rich in sulphate of iron. This bed bears amongst the Amber-diggers the name of the "White Wall" (*d*), because when it is dry it soon becomes covered with a sheet of sulphate of iron. Upon it, finally, there reposes (still in the southern part) a bed of coarse quartz sand, 3 feet thick, which is particularly rich in large granules of Glauconite (*e*). Of all these beds only the upper "Amber-earth" and the "Green Sand" can be compared with the corresponding beds of the northern deposit, the remainder being peculiar to this southern formation. The latter is also further distinguished by containing no fossils with the exception of shark's teeth, which occur everywhere in the "Amber-earth," and by the greater abundance of pieces of Amber in the beds overlying the Amber-earth, namely, in the so-called "White Wall," than in the "Green Sand" of the northern deposit. We have evidently here, therefore, the northern margin of a deposit, which filled up a basin of its own,—immediately connected, it is true, with the great sea-bed in which the northern deposit was accumulated,—but which was formed by the action of particular currents. All this is clearly and sufficiently explained if we assume that these southern deposits have been formed at the mouth of a stream. The following observations will confirm this hypothesis.

In order to advance the solution of the various disputed questions relating to the birth-place of Amber, I directed my attention particularly to those minerals which are found in the beds of the "Glauconitic Sand" in the form of pebbles; and it has been my good fortune to obtain such a series of these pebbles as throws considerable light on the problems in question. In the "Amber-earth" of the northern deposit are found somewhat abundantly pieces of a compact stone, from the size of a hazel-nut to that of a walnut, which is evidently the parent-rock of the "Green Sand," as it is composed of exactly similar granules of Quartz and Glauconite bound together by a marly cement. These fragments, however, vary amongst themselves, in the quartz grains being sometimes larger and at others smaller, and the cementing marl being sometimes more and sometimes less abundant. With them also are associated small portions of marl which contain only granules of Glauconite.

In the "Amber-earth" of the southern deposit, however, occur fragments of that Cretaceous rock which is so abundant as pebbles in the Diluvial deposits of Northern Germany, and which is known sometimes as hard chalk, or as chalk-marl, or again as earthy ("*todter*") limestone. It is characterized by its richness in such fossils as *Belemnitella mucronata* (Schl.) d'Orb., *Ostrea vesicularis*,

Lam., and *Terebratula carnea*, von Buch.; and it is composed of very small granules of Quartz, minute flakes of Mica, and little grains of Glauconite, cemented together by a matrix of marl. It has therefore exactly the same constituents as the above-mentioned pebbles, and corresponds to them so precisely that both of them are evidently only variations of one and the same rock. This marly sandstone, however, is still found upon the neighbouring Island of Bornholm,* and belongs to the Greensand of the Cretaceous formation, which also includes in its lower beds coarser glauconitic sand and glauconitic marl. It is therefore proved that the Tertiary "Glauconitic Sand" of Samland has been formed out of the Greensand of the Cretaceous formation, the younger beds of which constitute a part of the Danish Island. The marly sandstone is evidently the parent-rock of the deposit which I have already distinguished by the name of the "White Wall," and which is particularly characteristic of the southern deposit of the Samland formation.

We can determine, however, still more exactly the route over which the materials of the northern deposit were brought there, because in the "Amber-earth" small pebbles of Silurian limestone occur in some abundance. This fact is itself sufficient to prove that the "Green Sand" came from a region where the Cretaceous formation reposed on old Silurian rocks. Moreover, two large stones, which were once found in the "Green Sand" near Warnicken, contained fossils, namely, *Beyrichia Buchiana*, Jones, *Chonetes striatella*, Dalm., and *Rhynchonella nucula*, Murch., and resembled partly rocks of the Island of Gothland and partly those of the Island of Oesel, so that it is in the highest degree probable that they were derived from the land which connected these two islands during the Tertiary period. And as the Silurian pebbles and the "Green Sand" came together to Samland, so it follows that, at that period, the Greensand of the Cretaceous formation extended from Bornholm towards the north, through Gothland to Oesel, and occupied a great part of the area which is now filled by the southern half of the Baltic Sea. The Cretaceous rocks then formed, evidently, a broad coast-land round the old continent of Northern Europe, which consisted of the crystalline rocks of Scandinavia and Finland, and of Silurian and Devonian strata. They also extended from Scandinavia over the area which is now occupied by the northern part of the Baltic and its bays, as also so far as Courland and Esthonia far away towards the east. The northern and north-eastern part of that coast-land which lay north of the existing Samland must have been formed out of the oldest beds of the Cretaceous formation,—the loose Greensand and glauconitic Marl;

* For a recent account of the Geology of this Island see K. v. Seebach's 'Beiträge zur Geologie der Insel Bornholm.' Zeitschr. deutsch. Geol. Gesell. vol. xvii., p. 338.—Trans.

because upon the Danish Islands the deposits of that formation still form zones which follow one another in the order of their age from the north-east to the south-west. Add to all this that Cretaceous beds now crop out in the East of Prussia on the banks of the Niemen near Grodno, and that in the south Cretaceous beds to the thickness of 300 feet were bored through, in sinking a well near Thorn on the Vistula, and scarcely a doubt can then remain that the Tertiary deposits were accumulated in a sea-bed, which was formed by a great depression of the strata belonging to the Cretaceous formation.

The discovery of the parentage of the "Glauconitic Sand" also furnishes us with that of the Amber of Samland. The trees which yielded the Amber-resin must have grown upon the Greensand beds of the Cretaceous formation. Even as in North America at the present day the *Taxodium distichum* especially delights in the low and frequently inundated marsh-lands lying along the lower portion of the Mississippi, so during the Tertiary period may the Amber-trees have flourished best on the boggy coast which then surrounded the great continent of Northern Europe.

We can still more exactly draw the boundaries which then existed between sea and land, and with the assistance of a few hypotheses we can picture to ourselves the conditions under which the Amber was deposited.

We know not, indeed, how far in Prussia the beds of the "Glauconitic Sand" extend, as they are exposed only on the coast of Samland; but as we know that the beds of the Brown-coal formation were deposited immediately upon them, we can conclude, from the expansion which these beds possess in Prussia, what were the general boundaries of the old Tertiary sea, namely, that the whole of West Prussia, a neighbouring portion of Pomerania, and the western half of East Prussia, extending to about the thirty-ninth degree of longitude (from Ferro), formed the bed of a bay connected in the south-west with the great Tertiary sea, which covered the larger part of Northern Germany. The northern boundary of this bay left Samland at some distance, and was continued westward with some irregularity to Rückshöft, which lies at the foot of the peninsula of Hela, and where thick Brown-coal beds crop out on the coast of the Baltic. The bay was, as we have seen, a basin in the Cretaceous formation, and was bordered by widely expanded flat coasts, which mark the last upheaval of the district. Numberless rivulets with small discharge emptied themselves into the bay, and carried solid matter into it; but a larger stream from the north-west, which flowed through the southern portion of the Cretaceous land, also discharged itself here.

We have no knowledge of the oldest deposits which were formed in the bay; we can only conclude from the corresponding form-

ations in Belgium, where the Tertiary strata likewise repose on the Cretaceous beds, that the "Glauconitic Sand," which contains the Amber, may have been preceded by other deposits. In the meantime the coasts continued covered with luxuriant plant-growths—with that flora, in fact, the most delicate structures of which are still preserved to us in the clear Amber. If we consider that the temperature was then much higher than it is now, that the land descended from the highest North towards the South, and was there washed by a Middle-European sea, the temperature of which was, perhaps, elevated by a warm current, we shall then find it explained how this flora contains certain northern forms associated with plants of a temperate climate, and with others whose nearest allies now live in much more southern regions. Thus, Camphor-trees (*Cinnamomum polymorphum*, Heer) occur with Willows, Birches, Beeches, and numerous Oaks; amongst the Conifers the most abundant tree was a *Thuja*, very similar to the *Thuja occidentalis* now living in America, next to which abounded *Widdringtonia*, Pines, and Firs in great variety, and amongst them the Amber-pine. Many thousands of the last might already have perished, and while the wood decayed, the resin, with which the stem and branches were stored, might have accumulated in large quantities in bogs and lakes in the soil of the forest. In order to explain, however, that this accumulation of Amber could be suddenly broken up, floated away, and scattered, I assume that the coast of the district was at that time on the point of sinking. This supposition will appear less arbitrary when we see, as we shall presently, that alternate upheavals and depressions of the country may be positively proved to have occurred in the immediately succeeding period. If at that time the coast sank but slowly, nevertheless in the lapse of a few centuries, or even in a shorter time, a great portion of the flat coast-terraces might have been covered by the sea. The forest-earth was washed up by the waves, and the Amber carried into the sea. The greater portion being probably still attached to the wood, it could float about in the water for some time before it sank. The forest of the inundated coast was also destroyed; but the stems of the trees which floated out into the open sea were scattered about, only those pieces of wood which lay in the earth with the Amber sinking with it to the bottom. Thus perished the greater portion of the Amber forests; but it is not necessary to assume that they were all destroyed, as it is much more probable that in the higher districts of the country there still remained many forests which also were rich in Amber-trees.

The deposition of the "Green Sand" lasted for a long time afterwards, and pieces of Amber still continued to be washed into the sea; but it was only in the neighbourhood of the streams that

it was now deposited in greater quantity, probably because they flowed through either uninjured forests, or soil rich in Amber, in the higher parts of the country. What finally put an end to the deposition of the "Green Sand" it is difficult even to conjecture. Probably the land was so deeply depressed that the lowest beds of the Cretaceous formation,—the looser Greensand and sandstone,—were covered by the sea, and consequently protected from the action of rain.

Immediately upon the "Glauconitic Sand" lie the beds of the true Browncoal-formation. They very clearly form three deposits or stages (Fig. III., B^1, B^2, B^3), of which the two lower are certainly the most closely connected. The lower stage (distinguished by 1 in Fig. III.) is principally formed of "Quartz-sand," which generally contains no admixture. It is everywhere much more coarse-grained than the other varieties of sand belonging to the Browncoal-formation, but it is nevertheless found composed of particularly large grains in certain layers in the southern portion of Samland. At some places it alone (Fig. III., 1, B^1) constitutes the lower stage of the formation, which is everywhere of the same thickness, namely, from 24 to 25 feet; at other places the lower stage includes also a bed of clay (Fig. III., 2, 3, B^1). In order, however, to be able to explain the expansion of this clay, we must glance at the stratification of certain older beds which we have not yet discussed.

The beds of which we have hitherto spoken,—both the "Glauconitic Sand" and the "Quartz-sand,"—do not lie horizontally; but in proceeding from east to west along the north coast, they may easily be observed to sink gradually from the village of Sassau, then to proceed horizontally near Georgswalde, and to rise again from Warnicken towards Grosskuhren. They form therefore a trough-shaped synclinal, which is, however, very flat, as it possesses only a depth of from 40 to 50 feet in a length of nearly two miles. This trough is also seen again on the west coast; and numerous observations and measurements prove that it stretches from north-east to south-west through the western part of Samland, and in this direction becomes considerably widened and deepened. While its north-western margin is turned from the village of Grosskuhren on the north coast towards the west-south-west as far as the estate called Gross Dirschkeim, the eastern border appears to be extended from the village of Sassau in a southerly direction; but the site of the latter is not known exactly, as it passes through the midst of the country. The deepest point of the trough is near the village of Rothenen on the west coast, for while its base is 42 feet above the sea-level near Georgswalde, at the former locality it lies 10 feet below it. According to this the "Amber-earth" would occur near Rothenen at a depth of from 60 to 80 feet below the sea, but

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hitherto it has been proved here quite as little as at other localities on the north coast, where it exists at a considerable depth.

The trough has evidently been formed by the upheaval of its two sides, and it can easily be shown when this commenced, and that it continued slowly. This is taught us by the clay-bed (Fig. III., 2, 3.—[2]), already mentioned as occurring in the "Quartzsand" of the lower deposit, and as possessing a thickness of from 8 to 10 feet. It has exactly the same extension as the trough; it does not, however, belong to its infilling, but lies under it, forming a part of its base. Together with the "Quartzsand" it possesses the same thickness as the latter assumes, where it alone forms the lower division of the formation. It therefore follows that the upheaval of the sides began at a time when from 15 to 17 feet of "Quartzsand" had been deposited, and that while it continued, "Quartzsand" was thenceforward deposited only in the upheaved area; the resulting trough, however, was immediately covered with the mud, which is now hardened into a clay-bed. Where the clay is mixed with sand, it is not the "Quartzsand," but the fine Micaceous sand, which, as we shall see, forms the principal constituent of the infilling of the trough. This clay-bed, which I shall call the lower, because two others follow above it, belongs therefore, according to its situation, to the lower stage of the formation; according to its origin, however, it belongs to the middle stage, and thus it connects in the most intimate manner the two divisions, one with the other.

The materials which fill the trough (Figs. II., III., *B* [2]) are of three kinds; namely—Clay, Sand, and Browncoal; but the first and the last occur only here and there, and the Sand (Fig. III.—[4]) must be considered the most important deposit in this series. It is composed of fine quartz-grains with an admixture of numerous small flakes of Mica and small bright-green granules of Glauconite. At the same time it contains many pieces of coal, partly as powder or small particles, and partly as large tree-stems. The first form the layers and nests, which give to a section of the sand a brownish striped appearance. I have, therefore, called this deposit the "Striped Sand," and it is absolutely peculiar to the Prussian Browncoal-formation as a glauconitic Micaceous sand. It is, however, on that account particularly remarkable, because it contains Amber, which occurs, not indeed so abundantly, nor yet in one precise layer, as in the Amber-earth, but still in tolerable richness as nests in the brown stripes, and with small pieces of coal. As this Amber comes from a much dryer stratum than the blue "Amber-earth," it may be distinguished both by its external appearance and its greater solidity; and it is on that account more highly valued than that from the latter deposit, which, if it dries in the open air, becomes cracked and shivered.

Under the "Striped Sand" lies, here and there, a clay-bed (Fig. III., 2, 6-3), which I call the Middle; it contains the remains of an extinct Flora, changed into coal,—some large portions of stems, flattened branches and stalks in greater abundance, and many leaves. As at other places, here also it may be observed that the last belong in great part to deciduous plants, while the wood is almost entirely that of conifers. This Browncoal-flora differs from the older Amber-flora; either the latter had perished as a shore-flora, and we have in the former the plant-growths of more northern and more elevated districts, or — what is more probable — the climate and flora of northern Europe had already altered. This flora, indeed, contained many species of plants which at the present day are quite foreign to the region; but it was, nevertheless, very similar to the existing Flora. Poplars, Alders (*Alnus*), Buckthorn (*Rhamnus*), Ash (*Fraxinus*), and, among the Conifers, *Taxodium dubium* and *Sequoia Langsdorfii* formed the principal components of the forests of that period; with them, however, occurred also a *Gardenia* with pea-like fruit, a Fig, and species of the genera *Sapindus*, *Diospyros*, and *Banksia*. The clay in which these plant-remains lie sometimes passes immediately into Brown-coal (Fig. III., 6. 5); generally, however, the latter occurs higher, above the "Striped Sand," and forms the uppermost member of the whole series (Fig. III., 2. 5, 9).

It is very remarkable that exactly in the same area which the southern deposit of the "Glauconitic Sand" occupies, the lower division of the Browncoal-formation appears to be differently composed. Instead of the simple clay-bed which lies above or in the "Quartzsand" on the north shore, we find here three deposits of clay and argillaceous sand (Fig. III., 4 and 6—2′, 2″, 2‴), so that the "Quartzsand" forms only thin layers between them. No one can doubt that these clayey deposits owe their origin to the same source as the older argillaceous sand which we have previously distinguished by the name of the "White Wall." More than this, we can even determine exactly the area over which the current of the river made itself perceptible in the Tertiary sea. For on the portion of the coast belonging to the village of Gross Hubnicken occurs a district, 2,700 paces broad, which contains generally the same beds as the districts lying to the north and the south, with this difference, that the argillaceous portions are absent (Fig. III., 5). Instead of the three clayey beds of the lower stage we find striped sand deposited in the "Quartzsand" of this area (Fig. III., 4); and we cannot explain this otherwise than by the supposition that the current was here so strong that it carried on the argillaceous ingredients, and sorted out, as it were, the striped sand. At the same time this furnishes us with the proof that all the clayey beds of the lower stage belong to the "Striped Sand," and that, therefore, not

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only it, but all the infilling of the trough, with the Amber which it contains, was also brought there by the same river which during an earlier period had floated similar materials from the land into the sea. Thus the deposit of the "Glauconitic Sand," which appears to be connected with the Green Sand, is bound up in a wonderful manner with the overlying Browncoal-formation.

The deposits of the middle division of the Browncoal-formation have no important relations, for altogether they attain a thickness of only 22 feet, and even thus are unrepresented in one-half of the trough. The beds of the third division of the formation (Figs. II., III., *B* 3) are thicker and more wide-spread; they extend over the whole area of the Lower Stage, and repose partly upon the "Quartzsand" of that division, and partly upon the beds of the second stage. The succession of its various strata is also nearly the same as in the Middle Stage. At the base lies a clay-bed (Fig. III.—6), which passes upward into a clayey "Micaceous Sand" (7). Both contain plant-remains: pieces of wood and leaves of Conifers. As the clay and coal diminish in quantity, the "Micaceous Sand" becomes brighter, and at last white. It does not, however, contain Glauconite, and is thus distinguished from the "Striped Sand." Its upper layer is in great part composed of a Quartzsand, the grains being more equal and smaller than in the "Quartzsand" of the Lower Stage; but it can nevertheless only be looked upon as an alteration of the same. It is coloured grey or black by a great quantity of coal-dust, and is therefore appropriately called "Coal-sand" (Fig. III.—8). In it or in the uppermost layer of the "Micaceous Sand" sometimes occur, finally, true beds of Brown-coal (Fig. III.—9), from 6 to 8 feet thick, which are sometimes sandy, but at others consist of bituminized wood, and then contain a great quantity of gigantic trunks of trees. These upper Browncoals are those which are found also in other remote districts of the Province of Prussia covered by newer formations, for instance, near Braunsberg on the Passarje, near Schwetz on the Vistula, near Rückshöft on the Baltic, &c.

From what has now been stated it will be easy to carry on the history of Samland through the Tertiary period. When in the place of the "Glauconitic Sand," the deposition of the "Quartzsand" commenced, the relations of sea and land were not changed. As the "Quartzsand" in the southern districts is much coarser than in the northern, and as it forms in the latter area numerous intercalated beds between other strata, which do not occur in the former, we can infer that it was carried into the Bay from the great sea in the south-west. After the deposition of this Sand, and of the clayey ingredients which the river washed into the Bay, had continued undisturbed for some time, began the gradual

upheaval of the country lying east and north-west of the Bay. And the Bay itself, which had been so extended by an earlier depression, was now confined to the small flat trough whose most northerly portion we have now learnt to know. As it arose, however, it was filled up with the mud which the river carried into it, for the barriers which had formerly stopped its deposits were now destroyed by the upheaval of the coast. With the sand, which it derived from a variety of the Cretaceous Sandstone, poor in Glauconite, it took up also, out of the lakes and marshes through which it flowed, the Amber which was deposited there, and carried it into the trough, as well as numerous fragments of such plants as a river would bear away from an old forest. That the wood occupies as Browncoal chiefly the uppermost place in the series of deposits can perhaps be explained only by supposing that it floated about on the surface of the water until the trough under it was filled up, and it was pressed downward into the Sand.

About this time the coarse Quartzsand on both margins of the trough lay dry; but, as it is covered by the beds of the uppermost division of the Browncoal-formation, it is clear that a depression again followed the upheaval of the country, during which the deposits of the argillaceous "Micaceous Sand," of the "Coal-sand," and of the Browncoal, were accumulated. The "Micaceous Sand" of the upper division contains, however, no Glauconite, and as we are unacquainted with its origin, the influence of the river on these beds is also unknown, and the mode of their formation cannot be pursued any farther with certainty. No doubt the forests of an extensive shore-line again perished, and furnished the wood to the Browncoal-beds. Finally, the Prussian Bay of the North-German Tertiary sea was filled up, and while numerous deposits were formed in other parts of this sea, Prussia was laid dry by an upheaval of the rocks, and thus ended for a time the history of the country, but only to commence again after many centuries, when a harsher period of destruction succeeded to the clemency of the Tertiary Epoch.

This new period in the history of Samland began with the depression of the continent of Northern Europe. This region, which had endured since the oldest period of the earth's formation, was depressed first of all in the north-east, then in the south; and the Polar sea was enlarged as gradually, the valleys and deeper portions of the land being overflowed towards the south. The climate and all the conditions of the country were thus completely changed. The mountains projecting out of the sea were covered with glaciers, which extended down to the water. Icebergs and ice-flakes laden with the *débris* of rocks and with blocks of stone were detached from these glaciers and drifted towards the

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south; here they stranded upon the overflowed land, which was formed of Silurian and Cretaceous strata. The latter, with its many soft and marly beds, offered the least resistance to the water and the ice, and was therefore the most deeply eroded and destroyed. The clayey material, being more easily suspended in the water, was carried away by the sea and deposited as mud. The harder portions were mixed with the crushed components of the northern rocks, and were also widely distributed as sand by the water and the ice.

Without doubt there remained also at this period considerable deposits of Amber upon the Greensand beds of the Cretaceous formation, where the remains of the old forest soils existed, or the marshes and lakes which long ago had dried up or been filled with earth. With the soil, these also were now broken up, and with them the Amber was scattered in every direction. It can thus be explained why Amber-nests are found in the Diluvial deposits over all the German Plain, and why Amber also occurs in many other countries in Northern Europe, for instance, in Sweden, on the coast of the North Sea, &c. After the partial destruction of the Cretaceous beds, however, the Tertiary formation of Samland was laid bare to the fury of the waves and the pressure of the icebergs; it was destroyed in many places, and at last overflowed and covered with mud and sand.

The high coast of Samland presents an excellent opportunity for observing the nature and mode of the erosion of the Tertiary rocks by the Diluvial sea; and even the small coast-section (Fig. II.) enables us to perceive how here and there the upper beds only have been denuded, while at other places all the strata have been eroded down to the present sea-level, and even deeper. The narrow limits which have been assigned to this article, render it impossible for me to discuss very closely these relations, and I must therefore confine myself to the following remarks.

Of the deposits which were thrown down by the Diluvial sea, two divisions, having clear boundary lines, are usually distinguished, namely, the Older Diluvium and the Newer. The Older Diluvium (Figs. III., IV., α to δ) is deposited on the Tertiary strata to the thickness of from 10 to 40 feet; but where the latter have been denuded down to the sea-level, it may be seen reaching a height of 150 feet. Marl (which was deposited by the sea as mud), sand, large pebbles, and boulders are the principal components of the Older Diluvium. The sand, which has numerous varieties, distinguishable partly by colour and partly by the size of the grains, is characterized throughout Samland by always being rich in Glauconite, which was no doubt derived from the Greensand beds of the Cretaceous formation. The Newer Diluvium (Figs. III., IV., ε) consists of yellow sand and yellow loam; it is but slightly developed

in north-western Samland, and forms a covering of from 5 to 20 feet in thickness, spread regularly over all older deposits.

The destruction of the Tertiary strata had commenced before they were overflowed, no doubt by means of the masses of ice which were driven against the deeper beds. On thawing, the ice deposited the débris and stones with which it was laden. This explains the great gravel-bed which often lies imbedded in marl, near the remains of the Tertiary strata (as in Fig. IV., near A and E α). Often, however, surrounded by Diluvial masses, occur large blocks derived from the uppermost beds of the Browncoal-formation; they fell down by the destruction of the middle beds, and remain lying in the mud. Thus were large blocks of the older rocks washed away. In Fig. II. we see such removals, both in the east near Neukuhren and Wangen, as also westward near Georgswalde and Warnicken, —isolated remnants of the older beds being still seen projecting from their foundations. In Fig. IV., also, is exhibited on a larger scale the last-named coast district, where near A is seen one such remnant, and near E the step-like fractured margin of the Tertiary beds. These denudations, however, were also sometimes accompanied by dislocations, which were caused by the pressure of the masses of mud and sand which were thrown on the older beds. One such dislocation is shown in Fig. II. in the district of Rauschen; and near Rosenort on the west coast we have the remarkable case of the older Glauconitic beds being upheaved, and not only covered by Diluvial masses, but having also the same beneath them,—where they appear to have been thrust by lateral pressure.

In the deeper erosions occur marl and sand, not in a regular succession of beds, but thrust without order into each other, or heaped up against one another. Such a mode of arrangement cannot be explained in deposits from water; but they may nevertheless have arisen in two ways. At one time the ice-islands of the diluvial sea abundantly destroyed again the deposits which they had themselves formed, and the gaps which thus arose were filled up with other material. Still more generally it happened that the half-floating mud was forced upwards, by the weight of the sand which was heaped up on it, to such points where this pressure was accidentally slighter; by these means the mud penetrated into the overlying sand, as may be seen in Fig. IV. near B; or the sand beds were heaved up and thus fractured, as the sand beds D have been heaved up through the marl. All these changes took place slowly and in slightly agitated water. The proof of that is found in the circumstance that the broken and transported masses of the older beds are often found very near the places where they were detached; and great deposits of Tertiary sand are found with the ordinary Diluvial sand in the Diluvium, having been derived from the denuded portions of the Browncoal-formation.

"After the deposition of the Older Diluvium the land was raised up above the water, and lay dry for a long time. At that time, probably, numerous hills were formed as Dunes, for they can be proved in some cases; and thus by means of wind and water the land probably obtained its present features; but it was once more overflowed. The depression this time seems to have progressed faster and to a greater depth than before, so that the ice-islands drifting towards the south but slightly eroded the surface; and, on their melting, only the blocks which they had transported were deposited; and these are imbedded abundantly in the associated sand and loam.

After this the land once again emerged out of the water; and thus it is that through alternate upheavals and depressions it has gradually risen to the height which it now possesses; but the waves of the sea still continue the work of destruction which they commenced thousands of years ago, and yearly lessen the area of the country. If, however, other countries can only complain of the damage which the sea has inflicted on their coasts, it here amply repairs the loss it has caused. When lashed by storms, it tears up the Amber out of the deep-lying beds of Amber-earth; by the help of sea-weeds torn up at the same time from the bed of the sea the Amber is heaved upwards, and carried on the surface of the water; and when the storm abates and the sea becomes calm, it carries the Amber, together with pieces of older Browncoal and fresh marine plants, on to the beach, where a hundred hands are waiting to intercept it with nets. That is the "Amber-drawing," a trying occupation, which demands a strong and hardy frame, for the cold winter storms yield the richest booty. But many pieces of Amber, nevertheless, do not reach the shore, for the largest and heaviest pieces have already sunk to the bottom, and lie between the large boulders which cover the sea-bed. Therefore, in calm weather and with clear water, the inhabitants of the coast go in boats, and turning the stones with hooks fastened on long poles, endeavour to discover the Amber in the interspaces, and to draw it up with small nets. This is called "Striking for Amber."* For a long time people were contented with what Amber they could recover by these means from the sea; and these modes of acquisition still furnish the greatest quantity of the Amber which is obtained from Samland for commerce. For the last ten years, however, on all points of the coast where the Amber-earth does not lie too deep beneath the sea-level, endeavours have been made to lay it bare and to obtain the Amber immediately from it. The circumstance that it is overlain by a bed of very loose sand, which contains a large quantity of water, has hitherto impeded the attempts to open out the Amber-earth by subterranean mining-works. And to make this possible,

* "Bernstein stechen."

and therefore to render accessible the stores of Amber which lie hidden in the interior of the country, will be the next progress in the acquisition of these, in so many respects, remarkable fossils.

For the benefit of such students as desire to inform themselves more fully concerning the natural history of Amber, we append a list of the principal books and papers which have at various times been published on the subject; and we also venture to illustrate the paper of our contributor with a plate, which will convey some idea of the organic remains usually found in this fossil resin. For the accuracy of the list of works, therefore, as well as for the second plate, the Editors of this Journal are responsible. The specimens figured in that plate belong to the National Collection in the British Museum; and for the facts relating to the Insects embodied in the annexed explanation of it, we are indebted to the kind and able assistance of Mr. Frederick Smith, of the Entomological Department of that Museum.—Editors.

EXPLANATION OF THE QUARTO PLATE.

Fig. I. shows the north-western part of the coast of Samland.

Fig. II. is a section of the same line of coast.

In both figures the tinted portions distinguish those places where the Tertiary beds crop out above the sea-level. The white portions are those where Quaternary or Postpliocene deposits only are visible. The principal divisions of the Tertiary rocks are distinguished by different lines. *A* signifies the deposit of the "Glauconitic Sand"; B^1 the Lower Stage, B^2 the Middle Stage, and B^3 the Upper Stage, of the Browncoal-formation. The boundaries of the Synclinal Trough, which the Second Stage fills up, are shown by dotted lines.

Fig. III. exhibits vertical sections on a larger scale through three points on the north coast and three on the west. Here *A* distinguishes the deposit of the "Glauconitic Sand"; *a*, the "Amber-earth"; *b*, the associated "Quicksand"; *c*, the "Green Sand"; *d*, the so-called "White Wall"; *e*, the "Green Wall." *B* is the true Brown-coal formation; also 1, the "Quartz-sand"; 2, the intercalated clay-beds, which are represented on the west coast by three members, 2′, 2″, 2‴; 3, the Middle Clay-bed; 4, the "Striped Sand"; 5, the Lower Brown-coal; 6, the Upper Clay-bed; 7, "Micaceous Sand"; 8, "Coal Sand"; and 9, the Upper Brown-coal. *C*, Diluvial deposits:—α, coarse sand, gravel, and large boulders; β, Marl; γ, ordinary sand; δ, redeposited Tertiary sand;—all these (α to δ) belong to the Older Diluvium; ϵ is the Younger Diluvium.

Fig. IV. shows on a much larger scale than Fig. II. a small part of the coast near Warnicken, where the Tertiary beds are in great part denuded and replaced by Diluvium, exhibiting also the position of the Diluvial masses. The letters and numbers upon it have the same signification as in Fig. III.

EXPLANATION OF THE PLATE OF ORGANIC REMAINS FOUND IN AMBER.

Fig. 1.—A Dipterous Insect belonging to the European genus *Leptis*. Three times the Natural Size.

Fig. 2.—A Dipterous Insect belonging to the European genus *Echinomyia*. Enlarged one-half.

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Fig. 3.—A species of the Blind Travelling Ants (*Formicidæ*) of Africa, being either *Anomma rubella* or a closely-allied species. Twice the Natural Size.

Fig. 4.—A species of the spined *Formicidæ* belonging to the South American and African genus *Polyrhachis*. Twice the Natural Size.

Fig. 5.—A Dipterous Insect belonging to a new genus of *Muscidæ*, allied to the European genus *Tachinus*. Twice the Natural Size.

Fig 6.—A Clicking Beetle belonging to the European genus *Cardiophorus*. Twice the Natural Size.

Fig. 7.—A species of Heteromerous Beetle belonging to the family *Cistelidæ*, and allied to the genus *Statira*, in which, as in the fossil, the eyes coalesce. Three times the Natural Size.

Fig. 8.—A species of the tropical family of Beetles, termed *Eumolpidæ*, and probably belonging to the genus *Calasposoma*. Twice the Natural Size.

Fig. 9.—A species of *Termes* (White Ants). Twice the Natural Size.

Fig. 10.—Front view of a Spider belonging to the family *Attidæ*. Magnified four diameters.

Fig. 11.—An oblique Dicotyledonous Leaf. Natural Size.

In the above Explanation, the term "European genus" is not used as signifying that the genus is now *confined* to Europe, but only to show that it is still represented on the Continent.

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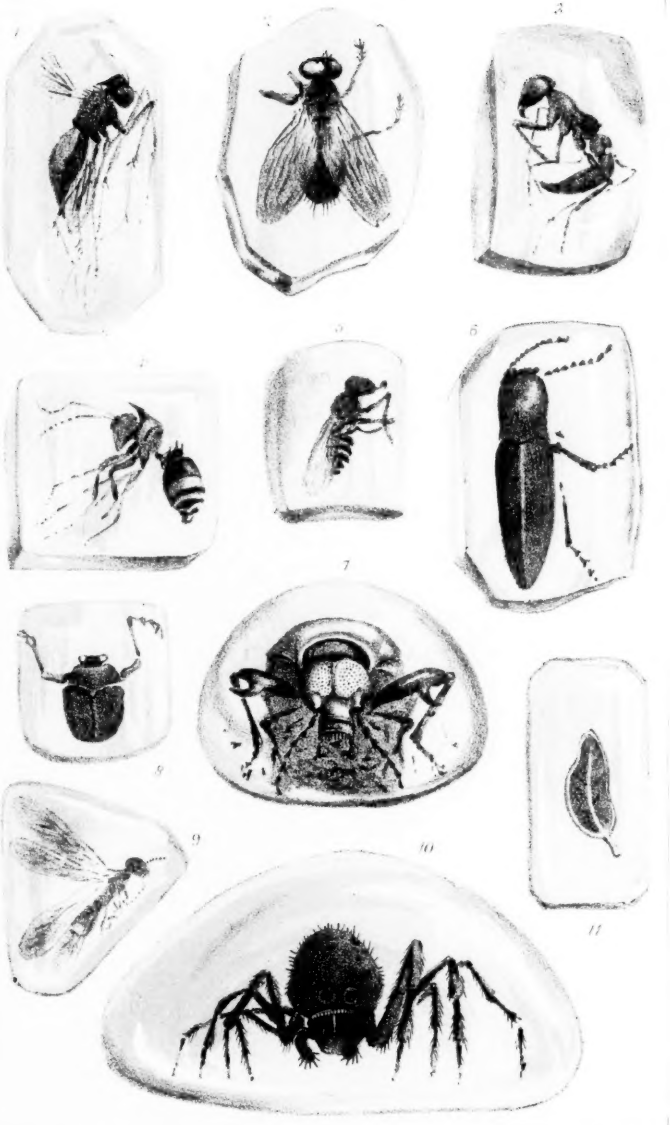

De Wilde lith. ad nat.
M.& N. Hanhart imp.

ORGANIC REMAINS IN AMBER

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XUM

V. SIR JOHN HERSCHEL AND MODERN ASTRONOMY.

ASTRONOMY is remarkable, as the solitary example of a science, for which exactness has been secured by the elucidation of the laws regulating a power which is associated with every form of matter. The laws ruling the influences of that power or principle, as exerted through space, have been developed with a clearness which removes every shadow of doubt.

When Newton determined by the most careful examination of facts, and by the penetrating power of his mental analysis, that every body circulating in space, was compelled to move in obedience to the force of Gravitation, acting according to the law of the inverse square, he furnished the key by which all astronomical problems connected with "the stars in their courses" could be solved.—The stone flung into the air by the playing child—the ball projected at high velocity from a piece of artillery—the planet rolling with majestic regularity across the celestial vault—the twin and triple stars circulating mysteriously about each other in the remoteness of the heavens—the yet inscrutable nebulæ—and the space-exploring comets,—are, each and all, equally bound to move in obedience to a force, of which we know only the *law* of action. But the knowledge of this law has placed a wand in the grasp of the astronomer, by which he feels out worlds, ere yet they are visible to human sense.

Every reflecting mind will naturally inquire, What is this all-pervading power which we call GRAVITATION, binding the Moon to the Earth, the Planets to the Sun, and the Solar System itself, to some immeasurably-distant star; which, though it be the centre of motion to our small group of planets, may be itself but the satellite of some yet grander luminary—distributing its energies from depths of space to which no telescope has ever penetrated? And such a mind—while impressed with the immensity of power displayed—will ever feel its littleness when compelled to own, that of the cause of that power it is deeply ignorant.

"The law of Gravitation," says Sir John Herschel, "the most universal truth at which human reason has yet arrived—expresses not merely the general fact of the mutual attraction of all matter; not merely the vague statement that its influence decreases as the distance increases, but the exact numerical rate at which that decrease takes place; so that when its amount is known at any one distance, it may be calculated exactly for any other."*

* 'A Preliminary Discourse on the Study of Natural Philosophy.'

Yet, the author of that paragraph was heard by the writer of this article to declare, on this point, the weakness of his knowledge —and, at the same time, with something like prophetic inspiration, to express a feeling, amounting to conviction, that Gravitation was the effect of vastly superior causes, ascending in grandeur of action, one above the other, until we reach the Great First Cause of All.

May it not be, that while we are groping our way amongst the interstices of matter, and learning a little of "molecular forces,"—to which we have given many names—we are slowly obtaining dim glimpses of modified forms of this force, at once so powerful and universal in heavenly space, and so subtle when confined in the labyrinths of earthly matter? However this may be, all "celestial weighings and measurings" (as Sir John Herschel phrased it, in one of those popular articles which he can write so well) are carried out entirely by our knowledge of the law of Gravitation, and thus is Astronomy made an exact science.

As we improve our instruments we shall see yet deeper into the heavens, and by long-continued and well-directed observations, we shall make new discoveries among the stars, and learn yet more of the arcana of space. But these discoveries, though they will enlarge our knowledge, will not disturb that which we know; and of no other science than Astronomy can this be said.

If we intended a review of modern Astronomy, it would be necessary to notice the labours of many men who have, in this country, in Europe, and in America, by their powers of observation, their unwearying industry, and their skilful analysis, largely increased the sum of human knowledge. Between the time when William Herschel discovered Uranus, and Adams pointed to the spot where a planet must exist, and where Neptune was found, many eminent men have yoked their names with astronomical researches of the highest value. Of none of these is it our purpose to speak; our only intention is to set forth, in brief, the labours of one man who has proved that he combines in his own person the assiduous astronomical observer, the acute mathematician, the deep-thinking philosopher, and the graceful poet,—that man being Sir John Herschel. It is not to many men that intellectual powers of so high an order have been given—it is not in many men that we find such perfect balancing of those varied powers—it is in few men that we discover such profound humility, and such a deep sense of reverence for the Creator of those works, the study of which has been a life-labour of love. When we have examples before us of superior intellects wandering away into error, deluded by the meteor-gleam of their own great, but irregularly-trained, and therefore, now uncontrolled, powers, it is of the utmost importance that the example of the brighter star, moving in brilliancy around the Centre of all good, should be con-

trasted with their meteor-flights—"a moment bright, then gone for ever."

Sir John Frederick William Herschel, Bart., was born in 1790 at Slough, near Windsor. He is the only son of Sir Frederick William Herschel, whose name is for ever associated with astronomical discovery. From the father the son derived his passion for the study of the stars,—and it may be incidentally noted here that in this family we have the rare example of the father, the son, and the grandson (Alexander Herschel) pursuing with great success the study of the exactest of the sciences. There is a pleasure and a purpose in tracing the progress of an individual mind, especially when that mind has made itself a place in the history of science. We have not the information necessary for treating inductively our examination of the development of the mental powers of the young John Herschel. We have heard numerous anecdotes of an absent, a retiring, a star-gazing boy, but, although there may be traces of truth in some of these, we believe they generally resolve themselves into the every-day expression of those who do not understand the condition of a meditative youth, loving solitude, because in solitude alone could he hold communion with nature's works and view her charms unrolled. John Herschel was a student of St. John's College, Cambridge, where he achieved the honourable position of Senior Wrangler, and became Smith's Prizeman in 1813. He appears from this time to have devoted himself seriously to those pursuits with which his father's name was already associated.

In 1816 we find him giving a large amount of time to observations on the multiple stars; these observations were continued, sometimes alone, and sometimes in conjunction with Sir James South, until, as the result of ten thousand observations, we find in the 'Philosophical Transactions for 1825' "a series of micrometric measures of 380 double stars, executed in conjunction with Sir J. South in 1821–2–3."

Previously to this we have the subject of this notice producing, with Dr. Peacock, the well-known Dean of Ely, a reconstruction of Lacroix's treatise 'On the Differential Calculus,' and he was at the same time a zealous student of chemistry and of the physical sciences. The 'Philosophical Transactions for 1826' contain an important paper, entitled "An account of a Series of Observations made in the Summer of 1825, for the purpose of determining the difference of the Meridians of the Royal Observatories of Greenwich and Paris." For several years, especially in 1825, 6, and 7, Mr. Herschel was occupied at Slough with the 20-feet reflector making observations on the multiple stars. The labour of these investigations may be judged of by the titles of the several series which were published in the 'Memoirs of the Astronomical Society,' and which we copy so far as to show the work performed:—

Series 1,	including	381 new double stars.
„ 2,	„	295 more new double stars.
„ 3,	„	384 more new double stars.
„ 4,	„	1,236 double stars, the greater part not previously described.

These observations were continued with the most untiring industry, and in 1832, Mr. Herschel published, as a fifth series, a catalogue of 2,007 double stars, of which 1,304 were new, and a sixth series was produced in the following year. In the 'Philosophical Transactions for 1833' there is a valuable communication, "Observations of Nebulæ and Clusters of Stars," with a 20-foot reflector. In this memoir we have a most careful examination of all the conditions observed in star-clusters and nebulous masses. Some two thousand of these mysterious classes of bodies were examined, and their physical construction, as far as possible, is described. The result of all this labour may be examined with much advantage in the 'Outlines of Astronomy.' In the paragraphs of that work which are devoted to this subject, the speculations of Sir William Herschel are cautiously reviewed. The "*nebular hypothesis*," as it has been termed, supposes the existence of an elementary form of luminous siderial matter, and its gradual subsidence and condensation by the effect of its own gravity, into more or less regular spherical or spheroidal forms. "Assuming that in the progress of this subsidence local centres of condensation, subordinate to the general tendency would not be wanting, he (Sir W. Herschel) conceived that in this way solid nuclei might arise, whose local gravitation still further condensing, and so absorbing the nebulous matter, each in its immediate neighbourhood, might ultimately become stars, and the whole nebulæ finally take on the state of a cluster of stars." Sir John Herschel's leaning towards this view will be evident from the following remarks:—"Among the multitude of nebulæ revealed by Sir W. Herschel's telescopes, every stage of this process might be considered as displayed to our eyes, and in every modification of form to which the general principle might be conceived to apply. The more or less advanced state of a nebula, towards its segregation into discrete stars, and of those stars themselves towards a denser state of segregation round a central nucleus, would thus be, in some sort, an indication of age. Neither is there any variety of aspect which nebulæ offer which stands at all in contradiction to this view."*

Another contribution to astronomical science was his 'Observations on the Satellites of Uranus,' published by the Astronomical Society; and this was followed by two series of micrometrical measurements of double stars, made at Slough with a seven-foot Equatorial.

* 'Outlines of Astronomy,' pp. 598, 599.

Whilst this indefatigable astronomer was thus busy with the most distant stars, and examining with philosophic acumen those conditions of matter which appear to indicate something which may well be taken for world-formation, he found time not merely to study several branches of physical science, but to write treatises, which are, even now, referred to as authorities upon every point of importance treated in them. The treatises on Sound, and on Light, published in the 'Encyclopædia Metropolitana,' are striking examples of that exactness which should ever belong to inductive science—of clear deductions, ever displaying the powers of the most philosophic mind, and a perspicuity of style which other writers on science would have been wise to imitate. These labours may not be regarded as belonging to astronomical science; but the theory by which the phenomena of light is explained, based as it is, by analogy, on the laws of sound, is intimately connected with the perfect understanding of the instruments employed in celestial surveys. Incidentally, too, we must notice in passing the 'Preliminary Discourse on the Study of Natural Philosophy,' which formed a volume of 'Lardner's Encyclopædia,' as a work singularly fitted to prepare the student for his labours. We cannot refrain from making one quotation from this charming little volume, to the study of which we have returned with advantage again and again. Discussing the question of the benefits to be derived from the pursuits of science which Sir John Herschel contends has peculiar tendencies to improve and purify the mind, he concludes:—"There is something in the contemplation of general laws which powerfully persuades us to merge individual feeling, and to commit ourselves unreservedly to their disposal; while the observation of the calm, energetic regularity of Nature, the immense scale of her operations, and the certainty with which her ends are attained, tends irresistibly to tranquillize and reassure the mind and render it less accessible to repining, selfish, and turbulent emotions. And this it does, not by debasing our nature into weak compliances and abject submission to circumstances, but by filling us, as from an inward spring, with a sense of nobleness and power which enables us to rise superior to them, by showing us our strength and innate dignity, and by calling upon us for the exercise of those powers and faculties by which we are susceptible of the comprehension of so much greatness, and which form, as it were, a link between ourselves and the best and noblest benefactors of our species, with whom we hold communion in thoughts, and participate in discoveries which have raised them above their fellow mortals and brought them nearer to their Creator."*

An article from the same pen on Physical Astronomy appeared

* 'Discourse on the Study of Natural Philosophy,' pp. 16, 17.

in 1823 in the 'Encyclopædia Metropolitana.' In 1832, 'A Treatise on Astronomy' was published as one of the volumes of the 'Cabinet Cyclopædia,' which was subsequently enlarged into the 'Outlines of Astronomy,' of which work the eighth edition was published in 1867. The extensive popularity of this treatise will be judged of from the fact of its having been translated into Russian, Chinese, and Arabic. In 1831 this eminent astronomer was created a Knight of the Royal Hanoverian Guelphic Order (K.H.), and he became a baronet in 1838. In the interval Sir John Herschel visited the Cape of Good Hope for the purpose of carrying out a similar system of celestial observations to those pursued at home. It has been often stated that this expedition was undertaken at the cost of the Government: this was not the case. A passage in a king's ship was offered to Sir John Herschel, but he declined to avail himself even of this, and the whole cost of the voyage and the expenses consequent on the removal of all his instruments were defrayed by himself. Four years were spent at Feldhuysen near the Cape of Good Hope. His labours in the Southern Hemisphere were published under the title of 'Results of Observations made during the years 1834–8, at the Cape of Good Hope,' completing the Telescopic Survey of the visible Heavens, commenced at Slough in 1825. This work was published at the expense of His Grace the Duke of Northumberland. The great object of Sir John Herschel was to discover whether the distribution of the stars in the Southern Hemisphere corresponded with the results of Sir William Herschel's similar labours, prosecuted mainly on the opposite side of the Galactic circle. In order that the observations made at the Cape might admit of comparison with those made at Slough, they were made with a telescope of the same optical power and according to the same method. These observations embraced a region of the celestial sphere, extending from the south pole of the Milky Way to a distance of 150° measured upon a great circle passing through it. The whole number of stars counted in the telescope amounted to 68,948, which were included within 2,299 fields of view. It appeared from these observations that the Southern Hemisphere is somewhat richer in stars than the Northern, and this is thought to indicate that the solar system is not situate exactly in the plane of the Galactic circle, but is displaced a little towards the North. M. Struve * remarks that the apparent position of the Milky Way presents an interesting accordance with this conclusion, for it has been found that its mean course does not coincide exactly with the great circle of a sphere, but with a parallel distant about 92° from the Galactic North Pole. By a computation, based on the star gauges in both hemispheres relative to the Milky Way, Sir John

* 'Etudes d'Astronomie Stellaire.'

Herschel found the stars visible in a reflecting telescope of eighteen inches aperture to amount to 5,331,572. He concludes, however, that the number really visible in the telescope is much greater than this, as in many parts of the Milky Way the stars appear so crowded as to defy counting.

Not only were all the observations, during his sojourn at the Cape, made by Sir John Herschel himself, but all the reductions of every sort which are found in the published volume were executed by himself. While at the Cape, Sir John Herschel observed, with his usual care, all the phases of Halley's comet, and noticed,—what had indeed been previously observed with regard to comets,—an enlargement of volume taking place simultaneously with the recess of the comet from the sun. During the interval between the 25th January, 1836, and the 1st of the following February, the volume of the comet was found by him to have increased in the proportion of 1 to 41·605. Sir John Herschel argues, that as the comet approaches the perihelion, the action of the solar heat will be constantly transforming the nebulous matter of which it is composed into the condition of a transparent invisible gas; and as this process necessarily commences at the exterior of the nebulosity, where the solar rays impinge, the immediate consequence will be a diminution of the volume of the comet. After the passage of the perihelion, the radiation of heat from the surface of the more condensed portion of the comet will not be sufficiently compensated by the solar heat, and the diminution of temperature hence arising, will occasion a precipitation on the surface of the nebulous matter suspended in a gaseous state in the atmosphere of the comet. This precipitation of nebulous matter will continue to go on, under the influence of the cooling process occasioned by the increasing distance of the comet from the sun, and the manifest result will be the rapid enlargement of the visible dimensions of the comet. According to the laws of equilibrium the lighter particles of the precipitated vapour will arrange themselves so as to form the superior stratum of the enveloping nebulosity of the comet. It is evident also that as this bounding stratum continues to diminish in density, it will attain a higher and higher elevation, while at the same time its increased tenuity will cause it to assume a more and more filmy aspect.*

It has been argued, from the slight retardation observed in Encke's comet, and from other phenomena connected with comets, that evidence has been obtained of the existence of an all-pervading "ether." While on the subject of comets, it will be advantageous —especially as showing the kind of reasoning which Sir John Hershel brings to bear on hypotheses of this class—to quote a

* 'Memoirs of the Astronomical Society,' vol. vi., p. 99.

few sentences from one of his popular Essays; he is writing of Donati's comet:—"It was not till the 14th August, or seventy-three days after its first discovery, that it began to throw out a tail, and to become a conspicuous object. Very soon after this, its first appearance, *a slight but perceptible curvature* was perceived in the tail, which on the 16th September had become unmistakable, and continued to increase in amount as the latter extended in apparent dimensions, till it assumed at length that superb aigrette-like form, like a tall plume wafted by the breeze, which has never probably formed so conspicuous a feature in any previous comet. To a certain extent, it is a common enough feature in the tails of comets, and is usually regarded as conveying the idea of their moving in a resisting medium, in a space, that is to say, not quite empty, as smoke is left behind a moving torch. But this is a very gross and inadequate conception of the peculiarity in question. The resistance of the 'ether,' such as the phenomena of Encke's comet, already noticed, may be supposed to indicate, is far too infinitesimally small to be competent to produce any perceptible deviation from straightness. Nor is it at all necessary to resort to any such explanation of the fact. Such an appearance would naturally arise from a combination of the motion the matter of the tail had (in participation with that of the nucleus) with the impulse given it by the sun, each particle of it describing—from the moment of quitting the head, an orbit quite different from that of the latter, being under the influence of a *repulsive force* directed *from* the sun—a curve of the form, called by geometers an hyperbola, nearly approaching to a straight line, and having its convexity turned towards the sun."

From time to time we hear of evidences of this repulsive force, existing as a power belonging to masses of matter. This must not be confounded with the repellant power manifested by an electrically excited body, or by that seen in the repulsion of the similar poles of magnetic bodies. With humility we venture to inquire, is not this repulsive force of the sun as pure an hypothesis as the resisting ether of stellar space?

In the 'Geological Transactions for 1832' there appeared a paper by Sir John Herschel "On Astronomical Causes which may influence Geological Phenomena."

The subject of this memoir is an example of much originality of thought.

With regard to the operation of astronomical causes upon climate, especially as elucidating former varieties of climate in geological history, Sir John Herschel refers to the influences of the sun and moon. The moon's mean distance is now on the decrease; also, the eccentricity of the lunar orbit is subject to fluctuations; both these causes would produce differences in the

tides. If the mean distance of the moon were diminished by only one-tenth of its actual amount, the mean rise and fall of the tides would be increased by a full third of their present quantity, which would, of course, produce a great increase in their erosive action on the continents, as well as in the transporting powers of the waters of the ocean over the materials of the land. He shows, too, how the secular variation of the eccentricity of earth's orbit may have produced both warmer and colder periods than the present. This idea, after lying dormant for thirty years, has recently been revived and extended by Mr. Croll, in several papers written on this subject, which is now materially affecting the reasoning of geologists regarding the history of ancient formations and the measure of geological time.

It is not possible within the limits placed at our disposal to mention several papers of great value which have from time to time appeared in the 'Memoirs of the Astronomical Society,' 'The Transactions of the Royal Society,' and in journals devoted to scientific literature. Amongst the more remarkable of those contributions, to our knowledge may be mentioned a paper investigating orbits of double stars; and another, "Determination of the most probable Orbit of a Binary Star," which were published by the Astronomical Society. "A notice of an error of two days, left uncorrected in the Gregorian reformation of the calendar," appeared in the 'Athenæum.' A paper "On a new Projection of the Sphere" was read by Sir John Herschel before the Royal Geographical Society in 1859. The principle of this projection was included in some of Gauss's general formulæ, but this was unknown to Herschel, and it had never before been reduced to a chart. The article "Telescope" in the 'Encyclopædia Britannica' was from Sir John Herschel's pen. (This is the only place in which will be found an account of the method of polishing specula, adopted by Sir William Herschel.) A Catalogue of Nebulæ and Stars, 5,078 in number, in order of right ascension, brought up to 1860, with precession for 1880, and descriptions, was prepared for the Royal Society in 1863. 'The Quarterly Journal of Science' in 1864 has a paper "On the Solar Spots" from the pen of this astronomer, in which he considers the speculation on the gradual variation of density in the solar atmosphere "an aggregation of the luminous matter in masses of some considerable size, and some certain degree of consistency, suspended or floating *at a level determined by their specific gravity* in a non-luminous fluid—be it gas, vapour, liquid, or that intermediate state of gradual transition from liquid to vapour which the experiments of Caignard de la Tour have placed visibly before us." To this article we refer our readers for an examination of this original idea.

Sir John Herschel in 1839 received from Oxford an honorary D.C.L.; in 1842, he was elected Lord Rector of Mareschal College,

Aberdeen; in 1845, Sir John was President of the British Association; in 1848, he became again President of the Astronomical Society, having filled that honourable office in the years 1828 and 29, 1840 and 41. In December, 1850, he was appointed Master of the Mint, which office he resigned in 1855.

The influence of the Herschels on modern astronomy has been considerable. Added to great mechanical skill, remarkable powers of observation, and unwearying industry, we find in them high philosophic powers. As they pursued their inductive researches, they were ever producing, as efforts of pure deduction, thoughts which advanced the science to which they were devoted. This has been most especially the case with Sir John Herschel. If any one doubts this, let him read his 'Preliminary Discourse on the Study of Natural Philosophy' or his 'Essays,'* containing his admirable addresses to the Astronomical Society.

While devoting the powers of his mind so zealously to astronomy, it must not be forgotten that Sir John Herschel found time for the most careful examination of several other branches of science. The chemical action of the sun's rays on both inorganic and organic matter forms the subjects of two memoirs printed in the 'Transactions' of the Royal Society, which are full of the most suggestive experiments and thoughts. By those researches he greatly advanced the art of photography, and led onward by his investigations to the production of those exquisitely sensitive tablets, by means of which the luminous elevations which appear on the edge of the solar disc during a total eclipse have been faithfully copied and preserved, and the moon has been mapped by a most unerring pencil, the rays reflected from her own mountains and valleys. Nor must it be forgotten that in 1819 Mr. Herschel communicated three papers to the 'Edinburgh Philosophical Journal' on the Hyposulphites. He then explained the peculiar action of the hyposulphites on chloride of silver, which placed, after long years, in the hands of the photographer the only agent, hyposulphite of soda, which can be employed efficiently to give permanence to his pictures. Without this agent the photographs of the solar clouds and the lunar mountains would be as transient as the rays by which they were at first delineated.

Sir John Herschel has ever maintained the serene dignity of a true philosopher; and his utterances of truths, which have inspired him with their divinity, have ever been received with delight by those who have listened to his subdued but impressive eloquence. How soul-elevating are the concluding passages of his address to the members of the British Association in 1845, with which we must close our notice of his labours:—

* 'Essays from the Edinburgh and Quarterly Reviews, with Addresses and other Pieces.' Longmans & Co. 1857.

"That astronomers should congregate to talk of stars and planets, chemists, of atoms; geologists, of strata, is natural enough; but what is there of *equal* mutual interest, *equally* connected with and *equally* pervading all they are engaged upon, which causes their hearts to burn within them for mutual communication and unbosoming? Surely, were each of us to give utterance to all he feels, we would hear the chemist, the astronomer, the physiologist, the electrician, the botanist, the geologist, all with one accord, and each in the language of his own science, declaring not only the wonderful works of God disclosed by it, but the delight which their disclosure affords him, and the privilege he feels it to be to have aided in it. This is indeed a magnificent induction, a consilience there is no refuting. It leads us to look onward, through the long vista of time, with chastened but confident assurance that science has still other and nobler work to do than any she has yet attempted; work which, before she is prepared to attempt, the minds of men must be prepared to *receive* the attempt—prepared, I mean, *by an entire conviction of the wisdom of her views, the purity of her objects, and the faithfulness of her disciples.*"

VI. SILURIA.*

Geology still advances with the rapidity which always characterized the science; and it needs considerable industry to keep oneself *au courant* with its progress. Sir Roderick Murchison, however, even in his old age, not only accomplishes this task, but still assists in no small degree to smooth the path and to hasten the march. More than this, he is ever foremost in the recognition of the improvements which the allied sciences constantly enable the geologist to make; and if he does not always join the ranks of the newer school of geologists in more doubtful and theoretical questions, who shall say that his opposition does not benefit the science by preserving his younger brethren from rushing into those speculative excesses which have too often proved so detrimental to the attainment of a true philosophy.

The most noticeable change in the present edition of 'Siluria' is the immense importance acquired of late years by the old gneissic rocks, described in the previous edition as the "Fundamental Gneiss" of Sutherland and Ross, which was there treated of as the

* 'Siluria: A History of the Oldest Rocks in the British Isles and other Countries; with Sketches of the Origin and Distribution of native Gold, the general Succession of Geological Formations, and Changes of the Earth's Surface.' By Sir Roderick Impey Murchison, Bart., K.C.B., D.C.L., LL.D., F.R.S., &c. Fourth Edition (including the Silurian System). London: John Murray, 1867.

oldest of the British stratified deposits; the reality of this, the latest of Sir Roderick's discoveries, being then still *sub judice*. In this edition we find a record of the correlation of this Fundamental Gneiss with the Eozoon containing Laurentian rocks of Canada, discovered by Sir William Logan, and about which, as the sepulchre of the most ancient of all known fossils, we have lately heard so much.

It speaks well for the breadth and catholicity of Sir Roderick's mind that he should have been able at once to acknowledge the reality of this discovery, and to grasp its important bearing on the geology of our own islands. He was also the first to recognize the high probability of his "Fundamental Gneiss" being of the same age as the Laurentian rocks, and to abandon the name he had himself given to the Scotch series, adopting that applied by Sir William Logan to the far more extensive development of them in Canada. Were anything still wanting to show the nature of our author's exalted opinion of Sir William Logan's discovery, it would be found in the graceful dedication of this edition to the eminent Canadian geologist.

Another most important alteration has been made by the author with reference to the reptiliferous sandstones of Elgin and Rossshire. The strata conformably overlie and apparently pass into deposits undoubtedly belonging to the Old Red Sandstone; but they long ago yielded remains of reptiles allied to those found in Triassic rocks of other localities. Sir Roderick Murchison, reasoning upon the stratigraphical evidence, had hitherto classified these upper sandstones with the Old Red deposits, while palæontologists considered that if reptiles of Triassic affinities existed in the Devonian or Old Red period "'twas passing strange." Fortunately, however, a specimen from the undoubted Triassic deposits of Warwickshire has lately been identified by Professor Huxley with the *Hyperodapedon*,—a reptile which had previously been obtained from the sandstones of Elgin,—and thus this vexed question has been decided in favour of Palæontology, and Sir Roderick Murchison has yielded to the stubborn fact, and excluded the portion of his former editions which treated of these strata as belonging to the Old Red Sandstone.

Our knowledge of the geology of other portions of Great Britain is also more complete than at the date of the publication of the last edition; and Sir Roderick has taken especial care to bring his work up to the present state of the science, so far, at least, as he can admit the views of other investigators. He has personally been concerned with Professor Harkness in the determination of the Permian age of large tracts in Westmoreland, which had previously been mapped as Triassic; and Mr. Geikie has shown that the red sandstones overlying the Ayrshire coal-measures

are of the same age. These facts have an important bearing on the question of our future coal-supply, and are, therefore, more especially worthy of record.

More than twenty years ago Sir Roderick Murchison made a great stride in advance of other geologists by showing that in certain cases the mineral riches of distant lands may be predicted by means of geological data. In the year 1844, having recently returned from the auriferous Ural Mountains, he examined a collection of rocks from Australia, and from their similarity with those occurring in the Russian range he expressed his surprise that "no gold had yet been detected" in the Australian "Cordillera." The fact that gold *had* been detected (the discovery being then unknown in Europe), is the strongest possible proof of Sir Roderick's induction being, in a scientific sense, a real discovery; while the memoirs which he published on the subject in the years 1844–6 testify that his comparison of the two regions was not a mere haphazard surmise, but the result of a scientific comparison of the rocks, and the earnest belief of a geologist in the method and principles of his science. The principles as to the distribution of gold in the earth's crust, upon which Sir Roderick then relied, have since undergone some alteration, but only to show that gold is somewhat more widely distributed than was at that time supposed. In place of the Lower Silurian deposits being the *only* matrix in which gold is found *in situ*, which was Sir Roderick's original induction, we now know that they are but the chief depositories of the precious metal. No one, however, acknowledges this extension of our knowledge of the possible sources of gold more freely than the author of 'Siluria;' and as the subject is one of great economic importance, we quote, *in extenso*, his most recent conclusions (p. 472):—

1. That looking to the world at large, the auriferous veinstones in the Lower Silurian rocks contain the greatest quantity of gold.

2. That where certain igneous eruptions penetrated the Secondary deposits, the latter have been rendered auriferous for a limited distance only beyond the junction of the two rocks.

3. That the general axiom before insisted upon remains, that all Secondary and Tertiary deposits (except the auriferous detritus in the latter) not so specially affected never contain gold.

4. That as no unaltered purely aqueous sediment ever contains gold, the argument in favour of the igneous origin of that metal is prodigiously strengthened; or, in other words, that the granites and diorites have been the chief gold-producers, and that the auriferous quartz-bands in the Palæozoic rocks are also the result of heat and chemical agency.

Some other additions to our knowledge of the geological structure of the British Isles have a purely scientific value. Such, for instance, are the determination of the Lower Llandeilo age of the

oldest rocks in the Lake-district of Cumberland by Professor Harkness, and the reference of the Devonian, or Old Red, rocks of the south-west of Ireland to the upper member of that formation.

In some respects the author of 'Siluria' holds aloof from proposed alterations in the interpretation of the relations of Palæozoic rocks of Britain. He does not accept Mr. Jukes's views on the Devonian rocks—a course in which he is supported by most of his contemporaries; nor does he yield to Mr. Salter's attempt to separate the Lingula flags from the Silurian System. We also perceive, with some surprise, that he does not completely agree with Dr. Holl's interpretation of the structure of the Malvern Hills, on the ground that the crystalline rocks have a strike parallel with that of the flanking Silurian rocks, Dr. Holl's statement being, that the former strike obliquely across the range. This, however, is a question of fact which will be easily decided by future observers.

In the last chapter of his work Sir Roderick Murchison gives a general view of ancient life from its earliest traces, and attempts to sketch the progress of creation from the commencement of geological time. He describes, first, a long period, characterized only by Invertebrata, and ending with the first appearance of Fishes in the uppermost Silurian deposits; this period of Fishes was followed by the appearance of Reptiles, and afterwards of Mammals, in subsequent formations.

Progression has long been a favourite hobby with our author, and if by it he simply means that Invertebrates appeared before Fishes, Fishes before Reptiles, and so on, who will quarrel with him. It is, then, simply a statement of a broad fact, and means very little. We suspect, however, that Sir Roderick has not sufficiently considered the fact that Fishes, Amphibia, Reptiles, Birds, and Mammals are merely *classes* of animals, whereas the great group of Invertebrata comprises about a dozen such subdivisions. No naturalist is yet in a position to show even the probability of all the classes of animals having appeared in the order of their organization, beginning with the most simple and ending with the most complex. And if the theory of progression is really the explanation of the order of creation, it should hold good for each and every of the orders, families, &c., into which classes are subdivided by naturalists.

The author then describes the former changes of the earth's surface, and illustrates their magnitude by striking examples of fractures, dislocations, and reversals of strata, coming to the conclusion that such great movements are inexplicable by reference to modern causes, so far at least as regards their intensity. At the same time he admits that "the former physical agencies were of the same nature as those which now prevail." Although we cannot bring ourselves to agree with Sir Roderick's views on this subject, we freely acknowledge the desirability of so eminent a member of the

"old school" recording his best arguments in favour of its principles; and we feel sure that, whatever can be said—for it has been stated by him at least as well as, probably much better than, it could be done by anyone else. One consideration we will venture to suggest to the readers of this review, and of his book:—If modern causes have operated for a certain definite time on the crust of the earth, their effect may be conventionally represented by a certain symbol; if for twice that period, then by a symbol of twice the value; and so on. Now the Silurian deposits are very many times more ancient than (say) the Eocene; and if the intensity of modern causes acting since the Eocene period has been sufficient to metamorphose Eocene strata into gneiss, to upheave them, and even to overturn them, how very much greater must be the effect of the *same* causes, continuously acting for such an immense period upon the Silurian deposits, which are so many times older than the Eocene.

These general considerations, however, form merely the author's peroration, and in no way affect the general value of the book, which is a perfect storehouse of facts carefully observed, and garnered for the use of the present and future generations of geologists.

CHRONICLES OF SCIENCE.

1. AGRICULTURE.

The need of extending the benefits of education to the children of agricultural labourers—the importance of defined relations between landlord and tenant—the necessity of continued legislation about the home and foreign cattle traffic—the limits put by the nature of the living things which the farmer cultivates to the enterprise of the agriculturist—the theory of land drainage—the relative values of our leading breeds of cattle—the cultivation of the sugar beet—the extension of the co-operative system—the improvement of the Irish butter manufacture — the activity of Farmers' Clubs and Chambers of Agriculture:—these are some of the subjects which have occupied the attention of agriculturists and agricultural readers during the past quarter. If we take the last subject first, it is that we may point out with what promptitude, activity, and force all these topics are now brought under the notice of the farmer as soon as their importance is established or even suggested.

With all that lack of union and organization which distinguishes agriculturists, when on any political question their voice or influence is desired, there is yet no occupation or profession in the country like theirs for such a frank and constant discussion by its members of the principles and methods of their business, as one witnesses at the meetings of Farmers' Clubs all over the country. Of this a few examples will suffice. The paper lately read by Mr. Bone, of Ringwood, before a Hampshire Agricultural Society, may be named as one. He discussed what he called the staple improvements of land: meaning thereby the permanent improvements of which the soil itself, apart from the mere current management of it, is capable. Among them is the improved texture which is conferred by the application of marls to sands, the processes of burning and draining clays, and the use of lime and chalk on both sands and clays. A very able and exhaustive treatise on what may be considered rather the landlord's than the tenant's interest in the soil was thus laid before a meeting of farmers, who were told a great deal of useful information for which they have to thank the geologist and chemist. Several of the tenant-farmers present related facts within their own experience, which not only proved the value of the processes Mr. Bone had recommended, but illustrated the cost of them, and therefore the need of a certain tenancy for a term of years, which alone would justify a tenant in incurring the expenditure involved. The relations of landlord and tenant, on which so much of the fertility of the soil is thus shown to depend, are the subject of constant

discussion before similar societies in all parts of the country. At the Hexham Farmers' Club—which has just lost its founder by the death of Mr. John Grey, who perhaps more than any other man in the country was trusted by all parties as the best exponent of these relations—the subject has been lately re-discussed under the guidance of Mr. C. G. Grey, who has succeeded his father in the management of the large estates of the Greenwich Hospital in the North of England. An elaborate lease was laid before the club for its approval, in which the style of cultivation was limited rather than defined; and among other particulars, a list of unexhausted manures was specified, for which at certain rates the tenant was to receive repayment on giving up the land. For lime applied during the last year of the lease, the outgoing tenant was to receive the full price paid at the kiln—for bonedust one-half the bill—for guano one-third. The faults appear to us twofold:—There is too much detailed instruction as to what, under penalty, the tenant shall and shall not do; and there is not a sufficiently detailed account of the repayments which are due to him provided he maintains good and energetic management till the close of the term. Many, at least, of those improvements to which Mr. Bone referred appear to have no place in Mr. Grey's schedule of repayments.

We may, however, find some explanation of this in another Farmers' Club discussion. At Maidstone, some weeks ago, a very interesting paper was read by Mr. Robertson, "On The Agricultural Differences between the North and South of England," in which it was pointed out that in the former it was the almost invariable practice of the landlord himself to undertake the expenditure involved in permanent improvements of the land. Thus the late Duke of Northumberland laid out more than half-a-million of pounds during his lifetime in the improvement of his Northumberland estate; and of this 200,000*l.* was spent on drainage, 5 per cent. being charged upon the tenant for the outlay. Other differences in management are of course explained on the ground of climate; and here we come upon those limits to agricultural enterprise resident in the very nature of the plants and animals which are its object, which some reckless innovators disregard,—to their loss. The cultivation of mangold-wurzel in the South is one of those specialities of management which are explained in this way; and the superiority of the turnip crop in the North is another; and both of these differences were commented on by Mr. Robertson, who urged on the attention of the Kentish farmers the compensating opportunities and possibilities which a southern climate places within his reach. The farmers' clubs of Ireland are in no respect behind those of England. At Athy, Ballymahon, and other places, many very excellent agricultural essays are read every year, on subjects whose discussion cannot fail to be of service to the Irish farmer.

Mr. W. Davison lately read a paper on the "Waste Lands of Ireland" at the former club, wherein land-drainage, for which Government aid is offered, was described and recommended, along with the subsequent cultivation of rape and other green crops; and the granting of long leases, for the encouragement of tenants with capital, was urged upon the landlord. As to the ultimate advantage of the process to all concerned, he quoted an instance where land, the property of Mr. La Touche, worth 5*s.* an acre, had been let, after 1,800*l.* had been spent on 140 acres of it, at 22*s.* an acre to a tenant, who was shortly afterwards offered 400*l.* for his interest in it. It is the relation of landlord and tenant, after all, which is at the bottom of all agricultural energy and enterprise.

The Morayshire Farmers' Club, which has heretofore taken the lead in introducing many agricultural improvements, was lately addressed by Mr. Geddes, of Orbliston, on the vexatious cropping clauses in leases, which often hinder the full use by the tenant of both his capital and his intelligence. He stated it as matter, not merely of opinion but of fact, which had arisen within his own experience, that land, however well cleaned and manured, tires of the same continued round of crops which the lease prescribes; that those who have most liberty of action in regard to the cultivation of the land, obtain the most produce and maintain the highest fertility, and are thus most serviceable to the country, the landowner, and themselves. He pointed out the Lothians as an example of the profits arising to everybody from liberal cropping clauses in agricultural leases. Elsewhere there is as good a climate and soil, originally as fertile, and where freedom and scope in the management of the land is given to the intelligence and enterprise of the tenantry, a larger capital will be attracted to the work of cultivation of it, larger produce will be obtained from it, and larger rents will be given for it.

At Cirencester, the other day, a very interesting lecture was given by Professor Wrightson, of the Royal Agricultural College there, before the Chamber of Agriculture, on the use to be made of books by practical farmers. He declared, from personal experience, that much time is lost in agricultural education from the student resident on a farm receiving no such preliminary instruction as books would give him, but being suffered to wander from field to field to gather such information as unassisted observation might give him. At the Central London Farmers' Club, steam cultivation, the risks of the foreign cattle trade, the policy or impolicy of a compulsory system for the education of country children, the advantages of the American cheese factory over ordinary English dairy management, the influences of railways upon agriculture, and the undeveloped power of British agriculture are among the subjects named for discussion during the year. The Chambers of Agriculture are engaged with the impolicy of the turnpike system and the

impending legislation on that, on the foreign cattle traffic, and on rural education. It is plain, we think, that the agricultural world is in this country alive to the many interests involved in its failure or prosperity.

Among the more important agricultural events of the past quarter must be named the proposal to re-establish the beet-root sugar manufacture among us. Twenty years ago this was attempted in Ireland, but failed, in some measure, perhaps, owing to the insufficient sweetness of the Irish-grown beet-root; but mainly, it is asserted, because of a faulty and imperfect manufacturing process.

Mr. Duncan, a sugar-refiner, dealing with no less than 300 tons of sugar weekly, is about to start the beet-root sugar manufacture in this country, and has advertised his willingness to contract for the purchase of 6,000 tons of beet-root next autumn, at 18*s.* a ton. His principal condition is that no farmyard manure shall have been put this year upon the land where they are grown. Over-luxuriance of growth is fatal to the development of much sugar in the juice. Purchasing these in October, he would grind them to a pulp, and thereafter press the juice out; boil it with lime, thus coagulating all albuminous matters; throw down the lime in solution, by passing carbonic acid through the liquid; and reduce the residual liquor by evaporation, till 50 per cent. of it was sugar, when it would be conveyed to the sugar refinery for further manufacture. The main difficulty in the way of the profitable growth of the sugar beet in this country is the small weight of root which must not be exceeded. Fifteen tons per acre are a full crop under ordinary circumstances, for the plants should not be more than two and a half pounds in weight, or the percentage of sugar will suffer.

An attempt to re-introduce the crop will, however, be made this year; and we understand that contracts have been already made with Suffolk farmers for a quantity of roots sufficient to justify Mr. Duncan in the erection of his manufactory.

Agriculture, in so far as it, too, is a trade, has shared in the recent excitement on the subject of co-operation. An association exists which professes to supply its members with agricultural implements and manures at manufacturers' and importers' prices. And even in the direct work of farm management, it has been attempted to make the workmen and the master fellow-labourers, both of them directly interested in the profits of the year. Mr. Lawson, of Blennerhasset, near Carlisle, has tried the principle of co-operation in this latter particular; but it appears that hitherto there have been no profits to divide. And it seems plain that these depend much more directly upon the skill and energy of the master than upon the mere co-operation of his men; which, after

all, is better secured by adopting the principle of piece-work payment, so that industry at once meets with its reward, than by offering as its stimulant a share in doubtful profits twelve months hence. The association for supplying cheap implements stands, perhaps, upon a sounder basis, for no doubt the charges made by agents and allowed by manufacturers are an excessive fine on customers; but we suspect that the competition of individual dealers is likely in the long run to make them the cheapest and most efficient agency for distributing these as well as all other kinds of goods to purchasers.

A paper by Mr. Maw on "Potatoe Culture," in a recent number of the 'English Agricultural Society's Journal,' deserves mention here as an example of an elaborate experimental agricultural research. Mr. Maw's experience proves that, the cultivation and manuring being alike, the weight of the crop is proportioned very accurately to the weight of the sets. Full-sized potatoes, from 4 to 8 oz. in weight, planted 10 inches or a foot apart, in rows 2 feet or 26 inches from each other, yield the maximum return. And where the sets were made to average 6, 4, and 2 ounces in place of 8, the crop per acre was found to drop from 26 tons per acre to 15, 14, and 11 tons respectively. Although the plots on which the experiments were tried were small, and the crops recorded almost incredibly large, yet the trials themselves were so numerous and the results so uniform, that the rule seems sufficiently established; and we may consider it as certain that the crop will generally vary as the weight of the sets; and as these are best planted at a certain distance apart, the larger sets are to be preferred.

The theory of land drainage has been under discussion recently owing to the assertion that the opening of a shaft to the surface of the land from the upper end of an ordinary drain, giving a direct connection with the air, facilitates the escape of water. This is of course an assertion which can be properly tested only by experiment; but it appears to us obvious that the broad surface and the whole substance of the soil are already entirely under the influence of atmospheric pressure, and that the operating cause in land drainage is plainly the mere weight of water which the land contains pressing downwards everywhere—into any channels, therefore, which may be provided for its escape. The provision of one opening more through which air can find a direct passage, if it will, from the sunlight to the underground channel, seems to us incapable of any power or influence at all on the process of land drainage which may be going on through that channel.

The agricultural statistics of the past year have just been published. They are interesting on a comparison with previous publications of the kind, as showing the unexpected changes which have gradually and unnoticed taken place in English and Irish

agriculture during recent years. Thus it appears, that during the past ten years the growth of wheat in Ireland has dropped from 544,348 acres to 280,549 acres, and in Scotland from 243,240 acres to 110,609 acres. No such comparison is possible in the case of England, for we have not a ten years' record in her case; but it is plain that such a record is very desirable, as pointing out how agricultural practice is drifting from the old lines without anybody otherwise having the chance of knowing it: so that national risks are gradually being incurred of which no suspicion had otherwise existed. Mr. Caird read a most elaborate and instructive paper the other day on this subject before the Statistical Society, pointing out the many ways in which the annual publication of our agricultural produce must tend to regulate trade, and correct the evils inflicted by misjudgment here upon agricultural as well as other national interests. We place the leading facts of 1866 and 1867 on record here for annual reference hereafter.

POPULATION, AREA, ABSTRACT OF ACREAGE UNDER CROPS, &c., AND NUMBER OF LIVE STOCK IN EACH DIVISION OF THE UNITED KINGDOM.

	Years.	England.	Wales.	Scotland.	Total for Great Britain.	Ireland.
Total Population	1866	20,276,494	1,187,103	3,136,057	24,599,654	5,571,971
Total Area (in Statute Acres)	..	32,590,397	4,734,486	19,639,377	56,964,260	20,322,641
Abstract of Acreage:—						
Under all kinds of Crops, Bare Fallow, and Grass	1866	22,236,737	2,284,674	4,158,360	28,679,771	15,550,231*
	1867	22,932,356	2,519,170	4,379,552	29,831,078	15,542,208*
Under Corn Crops	1866	7,365,170	521,674	1,366,540	9,252,784	2,174,033
	1867	7,399,347	521,404	1,364,029	9,284,780	2,115,137
„ Green Crops	1866	2,759,912	139,265	663,257	3,562,434	1,481,605
	1867	2,691,734	138,387	668,042	3,498,163	1,432,252
„ Bare Fallow	1866	760,979	109,878	94,080	964,937	25,419
	1867	753,210	86,257	83,091	922,558	26,191
„ Grass:—Clover, &c., under Rotation	1866	2,296,087	256,722	1,141,415	3,694,224	1,601,423
	1867	2,478,117	300,756	1,211,101	3,989,974	1,658,451
Permanent Pasture, not broken up in Rotation*	1866	8,998,027	1,257,721	893,066	11,148,814	10,004,244
	1867	9,545,675	1,472,359	1,053,285	12,071,319	10,057,072
Abstract of Live Stock returned:—						
Total Number of Cattle	1866	3,307,034	541,401	937,401	4,785,836	3,746,157
	1867	3,469,026	544,538	979,470	4,993,034	3,702,378
„ of Sheep	1866	15,124,541	1,668,663	5,255,077	22,048,281	4,274,282
	1867	19,798,337	2,227,161	6,893,603	28,919,101	4,826,015
„ of Pigs	1866	2,066,299	191,604	219,716	2,477,619	1,497,274
	1867	2,548,755	229,917	188,307	2,966,979	1,233,893
Number of Persons from whom Returns were obtained:—						
Occupiers of Land owning Live Stock, and Occupiers of Land only	1867	338,588	52,072	78,792	469,452	About 600,000
Owners of Live Stock only	1867	7,457	572	4,629	12,658	

* Exclusive of heath or mountain-land.

2. ARCHÆOLOGY AND ETHNOLOGY.

M. Paul Gervais has recently published an important work, entitled "Recherches sur l'Ancienneté de l'Homme et la Période Quaternaire," illustrated by nineteen quarto plates of figures of implements, ornaments, human bones and skulls, and mammalian remains, from various caves and stratified deposits of the Quaternary period. The scope of this work is very comprehensive, as the author treats the subject from several points of view. After certain preliminary observations, designed to show that the Quaternary period is really entitled to a separation from the Tertiary, M. Gervais enumerates the various kinds of proof which are commonly invoked in favour of the pre-historic existence of man in Europe, and then proceeds to subdivide the Quaternary period into four epochs, as follows:—(1.) The epoch of *Elephas meridionalis*, which can no longer be contested, since M. l'Abbé Bourgeois has discovered worked flints at Saint Prest, but which is difficult to separate palæontologically from the succeeding epoch. (2.) The epoch of *Elephas primigenius*, characterized by that species, and by *Ursus spelæus*, *Hyæna spelæa*, *Felis spelæa*, &c. (3.) The epoch of the Reindeer, characterized by the fractured remains of that animal. During this period, the animals which were especially characteristic of the preceding epoch appear to have become extinct, and in certain places their bones are found associated with the fragmentary remains of the Reindeer, as well as with the worked horns of that animal. (4.) The epoch of the pile-dwellings, of which the fauna appears to be the same as that of the present day, except that wild oxen and deer, though still existing, then roamed over districts where they are now unknown. This period is posterior to the extinction of the great mammals, and to the retreat of the Reindeer into more northern regions.

Our space will not allow us to discuss the author's valuable descriptions of the numerous caverns in France which he has explored, and several of which contain human skulls, nor his original observations on the species of mammalia contained in them; we must pass at once to a consideration of the manner in which the ancient people to whom these skulls belong have been so far modified as to have yielded the French population of the present day. M. Gervais states that the original inhabitants were Celtic; that after the Glacial period, during the long interval which preceded the invasion of Gaul by the Romans, the country was peopled successively by races from the East, chiefly from Asia, of which the tribes appear to have possessed distinguishing characteristics, similar to those spoken of by the ancient historians as characterizing the populations of the several provinces of France at the time of the

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Roman conquest. From the fusion of these several tribes with the original Celtic inhabitants arose the numerous varieties of people which existed at the latter period. And where the influence of the Roman invasion was least felt the aboriginal races have been preserved in the purest condition,—for instance, the Basques.

M. Gervais's book contains the discussion of too many large subjects to be thoroughly reviewed in a Chronicle; we therefore refer our readers to the work itself,—a most complete exposition of the subject in all its bearings, as connected with the history of France and of the French people.

In the numbers of the 'Intellectual Observer' for December and January, Mr. Llewellyn Jewitt continues his description of the Grave-mounds of Derbyshire, and their contents. As we stated in our last Chronicle, the greater number belong to the Celtic period, the smallest number to the Romano-British period, and an intermediate number to the Anglo-Saxon. The mounds of the Celtic period were described in the papers which we then noticed; in those now before us, the author describes the few Romano-British tumuli, and those of the Anglo-Saxon period. Mr. Jewitt states in explanation of the fact that so few Roman monuments occur in Derbyshire, that the Romans did not make regular settlements in that county, that they "seldom raised tumuli over their dead, or, in this country, placed any ostentatious monuments over their remains." The interments which have been discovered include examples of burial both by inhumation and by cremation. The articles found in the graves, of course, are not numerous; but they include pottery and glass, coins, fibulæ, armillæ, and other ornaments (of bronze and iron), knives, spear-heads, combs, &c.

The Anglo-Saxon period is remarkably well represented, the graves being generally rectangular cists, or pits cut in the ground, to the depth of from two or three to seven or eight feet. Mr. Jewitt gives an interesting account of the burial by inhumation; but it seems that cremation was the dominant practice. With the urns "but few articles, either of personal ornament or otherwise, are found;" but where the body had been placed entire in the grave the objects are numerous, and frequently elaborate, including "swords, knives, seaxes, spear-heads, umbones of shields, buckles, helmets, querns, drinking-cups, enamels, gold, silver, and bronze articles, baskets, buckets, draughtsmen, combs, beads and necklaces, rings, earrings, caskets, armlets, fibulæ, articles for the chatelaine, pottery," &c., examples of which are described by the author.

"Pfahlbauten in Meklenburg" is the title under which several reports by Dr. G. C. F. Lisch are being published in a collected form. These reports were originally published in the 'Jahrbuch' of the Society of History and Antiquities of Meklenburg, and two instalments of the collection have now been republished—namely,

one in 1865 and one in 1867. They contain, chiefly, descriptions of the "Pfahlbau" of Wismar, and of the bones and the objects of human workmanship which have been found in it. As some discussion arose in Germany concerning the authentic nature of this pile-dwelling, these collected reports by Dr. Lisch will, no doubt, be welcomed by students of Pre-historic Archæology.

M. Husson has published a collection of his pamphlets on the Antiquity of Man under the title, "Origine de l'Espèce Humaine dans les Environs de Toul par rapport au Diluvium Alpin." Most of these papers have appeared previously in the 'Comptes Rendus,' and the chief conclusion which the author endeavours to establish is, that man did not exist during the epoch of the Alpine Diluvium.

The antiquities found in the tumulus known as the Butte-Ronde have been splendidly illustrated in a memoir by the Duc de Luynes, entitled, "Notice sur des fouilles exécutées à Butte-Ronde près Dampierre (Seine-et-Oise)." They consist of Roman coins, bronze ornaments, iron tools, numerous ornamented jars, and other objects in pottery, and a few broken glass vases, with flint and stone implements, and some bones of an herbivorous animal, at least one of which had been submitted to the action of fire.

The second volume of M. Dupont's collected papers on the Belgian caverns, published under the title 'Notices préliminaires sur les fouilles exécutées dans les cavernes de la Belgique,' has recently appeared. It contains three pamphlets, two of which are descriptions of addition caverns, and the third, to which we shall confine our attention, is on the "Ethnography of the People of the Reindeer-age in the valley of the Lesse." M. Dupont infers from the pyramidal architecture of the skulls, and the lozenge-like form of the face, that the reindeer-folk belonged to the Turanian branch of the Uralo-Altaic family. They rarely attained the middle height, and generally speaking it may be said that individuals of small stature are abundant, while those above the middle height are exceptional. The characters of the pelvis and of the bones of the extremities are indicative of great muscular power and of considerable agility. The mortality of the infants and youths appears to have been very great; while the preponderance of the remains of females seems to show that large numbers of the men died from injuries which prevented their regaining their own homes. Several of the bones which have been obtained also exhibit evidences of disease. Amongst other noticeable points we may mention that M. Dupont credits these people with having been endowed with considerable curiosity and a love of investigation, as they made collections of fossil shells, pyrites, fluorspar, &c.; and with a love of decoration, as witnessed by the numbers of ornaments which have been found in the caves. Possibly to the latter cause should also be assigned the collection of shells, &c., most of which have been

perforated by them. M. Dupont speculates on their carelessness, their industry, their superstition, and their respect for the dead, all of which he ingeniously infers from circumstances connected with either the position or the material of the objects obtained from the various caves.

In the recently published volume of the 'Transactions of the Historic Society of Lancashire and Cheshire for 1866–67,' Mr. Henry Ecroyd Smyth gives his annual paper on the "Archæology of the Mersey District," this one being for 1866. It is perhaps rather more interesting than usual on account of its containing a record of the discovery of an early stone Celt in Parliament Fields, Liverpool; and an "omnium gatherum" thrown up on the sea-beach near Wirral, including objects of Primæval, Romano-British, Saxon, Early English, and Later English dates. The author prefaces his list of these remains by supporting in the main Dr. Hume's views on the latest submergence of the country near Liverpool against the opposition of Mr. Joseph Boult, although at the same time he differs from the former gentleman in some matters of detail.

Professor Schaaffhausen, of Bonn, delivered an address last September before the forty-first 'Versammlung deutscher Naturforscher und Aerzte' of Frankfort-on-the-Main, entitled "Ueber die anthropologischen Fragen der Gegenwart," which is published in their last 'Tageblatt.' This review of Anthropology, which is really an eloquent advocacy of it, is chiefly remarkable from being based on a view of the subject which is mainly conspicuous in Germany by its absence. It is directly opposed to the blasphemies of Buchner, and we strongly commend it to the notice of the Anthropological Society of London.

The new scientific magazine, entitled 'The American Naturalist,' —to which we have occasion to refer at length in our Zoological Chronicle—for January, contains an interesting "Account of some Kjoekken-moeddings, or shell-heaps, in Maine and Massachusetts," by the eminent naturalist, Dr. Jeffries Wyman. In it the author describes several such accumulations which he visited last year; but they have yielded nothing which indicates so high an antiquity as the similar accumulations of the Old World, although certain circumstances indicate the lapse of a considerable period of time, *e.g.*, the friable condition of the shells in the lower layers, the occurrence of a layer of earth between the two principal strata of which they consist, and that of the remains of animals not now known in the district. We may cite, in illustration of the last-named condition, the elk, which at present is not known to exist east of the Alleghany Mountains; the wild turkey, now virtually extinct in New England; and the great auk, which has receded almost, if not quite, to the arctic regions. All of these animals, however, have disappeared during the historic period of the con-

tinent. At Coluit Point, a metatarsal bone from the great toe of a human foot was discovered, otherwise these shell-heaps have been entirely unproductive of human bones. Remains of numerous animals, however, have been found in abundance associated with pottery, rude in its manufacture and its ornamentation; and implements of stone and bone, the latter being by far the more abundant, except in one locality.

The 'Anthropological Review' for January contains, besides several articles of interest, a report of Sir John Lubbock's paper on "The Early Condition of Man," which was read before the British Association at Dundee. In this paper the author examines the late Dr. Whately's theory that "man was from the commencement pretty much what he is at present; if possible, even more ignorant of the arts and sciences than he is now, but with mental qualities not much inferior to our own." Savages are considered by the supporters of this theory to be the degenerate descendants of far superior ancestors. Sir John Lubbock advocates the opposite view, that "man was at first a mere savage, and that our history has on the whole been a steady progress towards civilization, though at times, and at some times for centuries, the race has been stationary, or even has retrograded."

M. F. Garrigou has published, in the last volume of the 'Bulletin de la Société d'Histoire Naturelle de Toulouse,' a paper entitled, "Age de Renne dans la Grotte de la Vache, près de Tarascon (Ariége)," which has also been republished in the 'Annales des Sciences Naturelles.' The author finds evidence, over an area having at most a radius of 3 kilomètres, of the existence of man at four successive periods—namely, (1) the age of the *Ursus spelæus* and *Elephas primigenius*; (2) the age of the Reindeer; (5) the Polished Stone period; and (4) the age of Bronze and Iron.

In the 'Reliquary' for January is an account of the discovery of Pre-historic remains in the gravel-beds at Malton, Yorkshire, by Mr. Charles Monkman. This discovery has excited considerable discussion, and therefore, as this note is illustrated by views of the implement, and a rough section of the beds from which it is said to have been obtained, it will no doubt be welcome to those interested in the subject. The weapon is a polished greenstone axe, apparently belonging to the Neolithic or Polished Stone period, but it is said to have been found in the lower beds of the Malton gravel, and immediately beneath a thin bed of clay, said to have been in an undisturbed condition. The question is, How did a polished stone axe get into a position in which one would have expected to find only chipped flint implements? Unfortunately, the facts relating to the position of the axe depend entirely upon the testimony of a workman, who would be very likely to read the section of a gravel-pit altogether differently from an expert scientific investigator.

XUM

3. ASTRONOMY.

(Including the Proceedings of the Royal Astronomical Society.)

The news which has been received from America since our last Chronicle was in type suffices to show that—as we ventured to surmise—astronomers had not been mistaken in anticipating a fine display of the November shooting-stars in longitudes west of the British Isles. Considering how recently we have obtained any exact knowledge respecting the position of the meteor-ring in space and the motions of its members, the agreement between the predictions of astronomers and what actually took place is remarkably close. We mentioned half-past seven on the morning of November 14th as the probable epoch of maximum display: it will be seen from what follows that the earth passed through the richest portion of the meteor-belt about two hours later.

Professor Daniel Kirkwood, LL.D., assisted by Professor Wylie and several students, kept watch for meteors from 9h. 15m. P.M. to 5h. 15m. A.M., November 13th and 14th, at the Indiana University, Bloomington, Indiana. Although the sky was obscured by so dense a haze that only stars of the first magnitude were visible, they obtained the following results:—

November	13	from	9h.	15m.	to	12h.	0m.	.. 1 meteor
,,	14	,,	0h.	0m.	,,	3h.	15m.	.. 75 meteors
,,	,,	,,	3h.	15m.	,,	4h.	15m.	.. 351 ,,
,,	,,	,,	4h.	15m.	,,	5h.	15m.	.. 98 ,,

The maximum occurred at about 3h. 45m. Cincinnati time, corresponding to 9h. 33m. Greenwich time. At this time the rate was 12 per minute.

Captain Stuart obtained a better view of the meteors at Nassau, Bahamas. There is a slight misprint in the tabulated results, and hence some difficulty in determining whether the maximum display took place at 4h. 15m. or at 4h. 20m. This is not very important, however. At the maximum the rate was 21 per minute, though 3-fifths of the sky only were clear. The corresponding Greenwich time is 9h. 25m. or 9h. 30m. Other observers who had a more extensive view of the heavens counted nearly half as many again as Captain Stuart.

Lastly, Commander W. Chimmo, H.M.S. 'Gannet,' records the fall of an immense number of sparks near his ship, followed shortly by the explosion of a brilliant meteor near the East, emitting sparks like those of a rocket. He called the attention of the First-Lieutenant and Master, "who were on the bridge at the time, to the meteoric shower then in view, falling rapidly and perpendicularly; every now and then a brilliant meteor bursting and lighting up the

whole heavens." The hour of observation was from 5h. 20m. to 6h. 15m. A.M., local time, or 9h. 25m. to 10h. 20m. Greenwich time. A little consideration will show that the radiant point in Leo was near the zenith during the whole of this interval, so that all the shooting-stars would seem to be falling perpendicularly.

Commander Chimmo adds that at Trinidad, from 2 A.M. to daylight, 1,600 meteors were counted, only 693 of which fell before 5h. 30m. A.M. Some were reddish, others green, and one of a bright fiery purple, lasting many seconds.

Considering that during the whole time of the display the full moon obliterated all save the largest meteors, we are forced to conclude that the earth passed through a very rich stratum of meteors at about half-past nine on the morning of November 14th, 1867. Also it is very noteworthy that the accounts above referred to, are such as to leave no doubt that the real beginning and end of the shower were witnessed by the observers. This was not the case in England, in November, 1866. The shower in 1867 did not last more than five hours, whereas in 1866 it lasted at least six hours (counting from the earliest reported observation, made at Kishnagur, near Calcutta). The shower was heavy for but one hour. As the earth was traversing the thickness of the meteor-bed at the rate of 18,000 miles per hour, it follows that the total thickness was 90,000 miles, as against upwards of 108,000 miles in 1866; and that a stratum of about 20,000 miles in thickness was richly strewn with meteors. If we remember that the part traversed in 1866 was removed more than 500 millions of miles in November, 1867, and that there is every reason for supposing the meteor-band to be continuous, though varying in density (the variation being probably uniform, not abrupt), we shall be able to form a conception of the extent and importance of the November meteor-system.

Astronomers continue to be divided in opinion respecting the reputed change in the lunar crater Linné. Many hold that the apparent alterations are merely optical. On the other hand, Mr. Buckingham reports that the small crater which he was the first to notice, and which appeared as a small hill on the western border in December, 1866, and as a crater in January, 1867, has in every succeeding month approached nearer to the centre of Linné, increasing also in magnitude. As it is well known that the central cone of Vesuvius frequently shifts its position, Mr. Buckingham's observation seems to confirm the views of those who consider that Linné during the past seventeen months has been in a state of active eruption. Mr. Buckingham states that the change of place is at least a second and a half, corresponding to a distance of about a mile and a half.

M. Hoek remarks in the 'Astronomische Nachrichten' that

Comet III., 1867, in all probability belongs to the same system as Comets III. and V., 1859. The three planes in which these comets move intersect in the same line. M. Hoek had already suspected that the two comets of 1859 had a common origin, on account of the close resemblance between their elements, and the brief interval between their apparition.

The Gold Medal of the Astronomical Society has been presented to M. Leverrier for his elaborate investigation of the motions of Venus, Mercury, the Earth, and Mars.

Mr. Huggins has confirmed the discovery lately effected by the observers at Paris that bright lines appear in the spectra of three small stars.

The 95th asteroid was discovered by M. Luther at Bilk-Dusseldorf on November 23, 1867. It is of the 10th magnitude, or rather less.

Proceedings of the Royal Astronomical Society.

When astronomers first directed their attention to the determination of stellar distances, it was natural to expect that the brightest stars would exhibit more evidently than the rest that annual parallactic displacement on which the determination depends. This, however, was not found to be the case. Sirius, for instance, which shines four times as brightly as any other star visible in our latitudes, was found to exhibit a very minute parallax. Mr. Cleveland Abbe, of the Poulkova Observatory, has lately applied a careful and laborious process of calculation to a fine series of meridional observations of Sirius, made with the transit circle of the Cape of Good Hope Observatory. He deduces a parallax lying between 0″·37 and 0″·17—that is, it appears that the distance of Sirius lies between 563,000 and 1,224,000 times the diameter of the earth's orbit. It will be remembered that Henderson, who observed Sirius at the Cape, but with an inferior instrument, deduced a parallax of 0″·23.

The Astronomer Royal calls attention to the fact that the dark shadow in the great eclipse of August 17–18, 1868, coincides through a large portion of its length with the course of our mail-steamers between Aden and Bombay. A mail-steamer is to leave Aden on August 16, and will be due at Bombay on August 23, and a mail-steamer is to leave Bombay on August 11, and will be due at Aden on August 22. Both these steamers will pass through the dark shadow. Although a ship's motion renders it impossible to make many of the more important observations, yet several observations can be readily made on board ship. The red prominences could certainly be detected with a good opera-glass. The polarization of the corona could be readily examined by a polarizing test which acts by extinction, as the Nicol's prism. Perhaps even, with a

hand-spectroscope and narrow chink, lines in the spectrum of the corona might be seen. Marine and meteorological phenomena never yet observed might also be noticed.

Mr. Stoney, F.R.S., supplies a paper on the subject of the same eclipse. Viewing the corona which is seen during a total eclipse as caused by the sun's enormous outer atmosphere projecting beyond the disc of the moon, he considers that the examination of this phenomenon through a spectroscope adapted to an equatorial telescope would be likely to yield results of extreme interest and importance. He points out that the shell of excessively faint cloud which seems to lie at a distance of 8″ or 10″ from the edge of the sun's disc should be observed both from a central station and from stations close to the northern and southern limits of totality, so that we may be enabled to determine whether it is continuous all round the disc. It is desirable also that the flame-like protuberances should be examined, in order to determine whether their spectra resemble the solar spectrum, or on the other hand consist (some of them, at least) of bright lines. We should thus learn whether these objects resemble mists or true vapours.

Mr. Stone applies a careful investigation to Professor Newcombe's determination of the solar parallax. Professor Newcombe deduces the solar parallax from the parallactic inequality in the earth's motion, a method already applied by Leverrier, and described by us in a recent chronicle. But the value deduced by Professor Newcombe differs considerably from Leverrier's. In place of a parallax of 8″·91, Newcombe obtains the value 8″·81. It will be remembered that the estimate of the moon's mass is a very important element in the inquiry. Newcombe makes the moon's mass $\frac{1}{81\cdot05}$ of the earth's; Leverrier's labours corrected by Stone gave the fraction $\frac{1}{81\cdot45}$. After a careful revision of the processes applied by Leverrier and Newcombe, Mr. Stone arrives at the conclusion that Newcombe should have obtained the value 8″·87 for the solar parallax, if his own estimate of the moon's mass were adopted, and the value 8″·89 if Leverrier's estimate were taken.

In a later paper Mr. Stone determines the moon's mass independently, retaining all terms of the third order in the Lunar Theory. He obtains the following relation:—

$$\frac{\text{Moon's mass}}{\text{Earth's mass}} = \frac{1}{81\cdot38}$$

This result depends on the adopted values of Luni-Solar Precession (50″·378), and Nutation (9″·223).

Mr. Stone deals also at length with Bessel's Mean Refractions. From the existence of several small but systematic discordances, he had been led to form the opinion that the refraction-corrections used at Greenwich for zenith distances less than 85° are too great.

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He finds that the refraction of Bessel's 'Fundamenta' require to be diminished in the proportion of 0·99797 to 1, to be correct for Greenwich. He has examined also the Melbourne observations for 1863, 1864, and 1865, to test the accuracy of the proposed diminution of the Greenwich tabular refractions. A somewhat remarkable result has attended the inquiry. He finds evidence of a difference in mean refraction towards the south and north at Melbourne. He ascribes this to the position of Melbourne. The refractions towards the south are greater, because the ocean lies to the south, so that there is more moisture in the air-masses which lie in that direction. The refractions toward the north are less, because the effective strata of air have been to a considerable extent deprived of moisture.

Mr. Penrose has attempted to facilitate the prediction of occultations and eclipses by the application of geometrical constructions. Such methods are not, perhaps, likely to supersede the more rigorous processes adopted by the compilers of our ephemerides, but they are valuable in many respects. We believe that there is room for a great extension of geometrical processes to the illustration of many astronomical phenomena which at present are either dealt with by abstruse processes intelligible only to the advanced mathematician, or so roughly and imperfectly illustrated that the amateur astronomer is more likely to adopt incorrect impressions than to acquire any real information.

Mr. Browning has ascertained that the colours of stars are not nearly so intense in telescopes of large aperture as in small instruments.

The following summary of the results of the examination of three long periods for the determination of Mars' Rotation-period may prove interesting. Each period begins from Hooke's observation of Mars, on March 12, 1666, 12h. 20m. (astronomical time and new style), and the periods extend severally,—(i) to April 24, 1856, 10h. 50m., (ii) to November 26, 1864, 11h. 46m., and (iii) to February 23, 1867, 6h. 15m.:—

Int.	Int. in Secs.	Cor. for Geoc. Long.	Cor. for Phase.	Corrected Int. in Seconds.	No. of Rotations.	Resulting Rotation Period in Secs.
(i)	5999524200	— 0°	—12°	5999521246	67682	88642·737
(ii)	6270650760	—248°	0°	6270589696	70740	88642·734
(iii)	6341394300	—273°	+3°	6341326590	71538	88642·734

Mr. Proctor mentions that nothing is doubtful in this table except the correction for Geocentric longitude (which, however, may be depended on as being within 1° of the truth) and the correction for phase. The last correction depends only on the accuracy of the drawings of Mars by Hooke—at one end of the intervals, and by

Dawes and Browning at the other. Hooke took two closely according views separated by an interval of 10 minutes; Dawes' accuracy of delineation is beyond question; and though Browning has had less practice in observations of this sort, yet he has already acquired a high reputation for accuracy and care, and further his drawing gives results closely according with those deduced from Dawes' views. Hence we can scarcely doubt that the mean of the above rotation-periods, or 24h. 37m. 22·735s. is very near the true rotation-period of Mars. We notice, however, that an error of 1° in any of the corrections corresponds to an error of about $\frac{88}{70} \times \frac{1}{360}$ths (or very nearly $\frac{1}{250}$th) of a second, or ·0036s.; so that Mr. Proctor's result cannot be held to be trustworthy beyond the second place of decimals,—perhaps even not beyond the first. We may assume that Mars' rotation-period lies *certainly* between 24h. 37m. 22·75s. and 24h. 37m. 22·71s., and a corresponding error therefore exists in Kaiser's estimate—24h. 37m. 22·6s., and Mädler's—24h. 37m. 23·7s.

Mr. Harrison supplies an interesting paper on the moon's insolation. Assuming that the moon's substance has a capacity for heat, the mean maximum state of insolation of any hemisphere would evidently be attained when the largest surface has been continuously exposed to the sun's heat for the longest duration of time. Accordingly, the visible hemisphere would be heated to its greatest possible extent during the third, or last quarter, when the half-moon then illuminated has been subjected to the solar radiation for a mean period of 265·5 hours, and the remaining half, now in shade, has very recently received the sun's rays for a period of equal duration. Now, the heat thus assumed to be acquired by the moon, and radiated to the earth, is dark heat; and it has been shown by Professor Tyndall that the aqueous vapour in our atmosphere has a power of absorbing dark heat. Accordingly, instead of heating the earth, this heat would be employed in heating the air above the clouds, and causing increased evaporation from their surface. Clouds would thus be raised to a higher elevation, and, under favourable circumstances, would even be dispersed. Thus, there would be a diminished check upon the radiation of terrestrial heat, and a sensible fall in the temperature of the air near the ground would necessarily follow; and results of a precisely opposite character would occur at the period of minimum heat in the moon's visible hemisphere. The daily mean temperatures at the Oxford, Berlin, and Greenwich Observatories, when arranged in tables according to the age of the moon, show that the temperature of the air near the ground is sensibly affected. The maximum mean temperature occurs on the average on the sixth and seventh day of the lunation, and the minimum soon after full moon—results which confirm Mr. Harrison's views in a remarkable manner.

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With reference to these speculations we must note that inquiries specially directed to the subject are required before an opinion can be formed. It must be remembered that the moon rises to the meridian at a different part of the day in each lunation; and meteorologists are familiar with the fact that the hygrometrical state of the air varies at different hours of the day. There is the epoch at which—on the average—clouds are most numerous; the epochs at which the absolute quantity of vapour in the air reaches its maximum and minimum; and the epochs (not necessarily the same as the preceding) at which the humidity of the air is least or greatest. Now we clearly cannot neglect the consideration that the moon's influence—which certainly exists—may vary in different parts of each lunation, *not* for the reasons assigned by Mr. Harrison, but because it is exerted at more or less favourable hours of the day. And, although we have not space here to explain the considerations on which our opinion is founded, there are reasons for anticipating that the first and third quarters, when the moon reaches the meridian in the evening and morning, should be marked by a greater apparent influence—one way or the other—than the second quarter when the moon reaches the meridian near midnight, a period of the day far less *critical* (as respects hygrometrical conditions) than the two former. We may be permitted to question the justice of Mr. Harrison's conclusions, when we find that a marked rise in the temperature occurs in the middle of that quarter which should exhibit (and does exhibit *on the average*) the lowest temperature. It is true Mr. Harrison finds a reason for this, in the supposition that *fresh cloud may have been found to arise a day or two before the third quarter*, to supply the increased demand for vapour at that period. But when opposite effects can thus be assigned to the operation of the dark heat assumed to be emitted from the moon, a little uncertainty is thrown over the whole subject.

As respect the heating of the moon's surface it may be remarked that although, undoubtedly, an enormous quantity of heat is poured upon a lunar hemisphere in the course of the long lunar day, yet we have no means of knowing how this heat is disposed of. Nearly all of it may be at once radiated into space, or a large portion may be consumed in effecting changes—as of solids into liquids or of liquids into vapours—imperceptible to us, and followed by a return to the original state during the long lunar night. It seems hardly conceivable that the heat emitted during the latter process of change should become in any way sensible to us. Far more probably the heat we actually receive from the moon is reflected towards us precisely as the moon's light is.

Messrs. De la Rue, Stewart, and Loewy communicate the results of Observations made on Sun-spots, in Kew and in Dessau, during the year 1867. Hofrath Schwabe reports that the uniform

brightness of the sun's surface observable in the beginning of the year and the almost total absence of faculæ, both which phenomena were lately submitted to the attention of astronomers, have disappeared, and since October the luminosity has again diminished near the edge of the sun's disc.

Mr. Browning has invented an ingenious contrivance for reducing the angular velocity of meteors, so as to facilitate the observation of their spectra. The contrivance consists of "a direct-vision prism, having in front of it a deep concave cylindrical lens, and in front of that a double concave lens of the usual kind." With this apparatus he has found it easy to obtain the spectra of balls shot from a Roman candle, placed but a few yards from the instrument. The angular velocity of the projected balls (estimated from the instrument) is, of course, very great under such circumstances, yet the characteristic lines of baryta, strontia, &c., can be readily distinguished in their spectra.

4. BOTANY AND VEGETABLE PHYSIOLOGY.

England.—*A new British Morel.*—In the 'Journal of Botany' we read of a new British fungus. It was first found in a hedgerow, near Kingskerwell, South Devon, by Miss Lott, of Barton Hall, at the end of last April. The first specimens were sent to Mr. W. G. Smith for identification, and it has since been found elsewhere. It is a very large form, and when well grown is one of the finest fungi of our flora; the spores are oval, yellow, and depressed, having a length of ·0007 inch. The substance of the flesh is not so firm as that of our common Morel (*Morchella esculenta*, Pers.), and is not so readily dried; it becomes moist, and is apt to decompose. It is, however, excellent for the table, and with a little pains may be readily dried for winter use.

Different kinds of India-rubber.—In the same journal is a most interesting article, by Mr. James Collins, on india-rubber. It appears that india-rubber first became known when Columbus discovered America, and was described by the earlier travellers as a great curiosity. The natives used it to make balls, with which they played a sort of game like tennis. The ordinary practice of coagulating the milky juice of the cow-tree on bottle-moulds held over a fire is well known: it appears that this is the method practised on the Amazons; but that in other districts and countries sheets are prepared, or the juice is dried in the sun. Some persons have supposed that the black colour of parts of india-rubber is due to the smoke of the fire over which it is dried. This is quite a mistake; freshly prepared india-rubber is, as the Indians make it,

of a pale yellow colour; it becomes black by exposure to the air. Inferior kinds of india-rubber are blacker than others, and contain a sticky, resinous fluid, which can be squeezed out. Other sorts are white and hard when dry, resembling gutta-percha in that they become elastic when heated gently. The first person to advocate the use of india-rubber for erasing pencil-marks (whence has arisen its name) was the great Dr. Priestley, and at the end of the last century you might buy a square inch of india-rubber for 3*s.*! The vast variety of uses to which india-rubber has now been put has caused it to be searched for and discovered in every quarter of the globe; and though the principal supply is still from America, it has been found in use among the natives of Asia, Africa, and even Australia, and is now imported thence. Of the American india-rubber, the original and best is procured from *Hevea Guayanensis* (*Siphonia elastica*), and other species of the same Euphorbiaceous genus: it is known as Para-rubber. Pernambuco rubber is the product of *Hancornia*, an Apocynaceous genus, and is an excellent sort. *Couma*, another Apocynaceous plant, yields a hard, white, gutta-percha-like substance, which is sometimes sold as "rubber milk." The *Castilloa elastica*, belonging to the same natural order as the nettle, is the plant which yields the somewhat inferior "rubber" of Central America. Guatemala rubber is the worst kind, and is quite black and resinous. The juice of the *Castilloa* is not coagulated by heat, but by the juice of a vine-like plant, which grows in the same forests, and is called "Achuca." Species of *Micrandra* and *Siphocampylos* (Euphorbiaceæ) yield small quantities of "rubber," of good elasticity. The Asiatic "rubber" has a different appearance to the American, and is much inferior, on account of its frequent impurities. From Penang, Sumatra, Malay Peninsula, and Borneo a "rubber" is imported, the produce of *Urceola elastica* (Apocynaceæ), discovered in 1798, but its value till lately was only 2*d.* a pound, whilst Para fetched half-a-crown; its value is now about half that of the Para. From Assam the rubber brought is the produce of the *Ficus elastica*, which we so often see now as a drawing-room plant. In Java, species of *Ficus* (Urticaceæ) and *Vahea gummifera* (Apocynaceæ) yield a good "rubber." The African india-rubber is brought from Mauritius and from the West Coast; that from Mauritius is probably imported from Madagascar, where *Vahea* and *Ficus* grow; that from the West Coast is imported in casks, in the form of balls, slabs, and "tongues." It has a very foul smell, and is only valued at 11*d.* a pound—the cheapest of any. By some this is believed to be produced by *Sycomorus Guineensis* (Urticaceæ), whilst others believe that it exudes from some Apocynaceous plant, at present not known. Fragments of rubber have been received from Australia, but it is not known what plant produced them.

The Dragon-tree of Teneriffe.—It appears that this celebrated botanical curiosity has recently been removed from its time-honoured situation; in fact, has been blown down by a storm. No care appears to have been taken by the Spaniards to avoid such a mishap, which was, to say the least, not unlikely to happen, when we remember that the tree's age is by many competent persons estimated at more than six thousand years. When Baron Humboldt visited the tree in 1799, he calculated its circumference at about forty-five feet near the root, whilst M. Fenzi, of Florence, who has been there since, gives a circumference of no less than seventy-eight English feet. Last year it was in good health and condition, the crown covered with innumerable panicles of scarlet fruit, and altogether as vigorous as ever. The great trunk is hollow, and it is maintained by some authorities that the tree as it at present stands, or till lately stood, is to be regarded not as a single tree, but as an agglomeration of individuals, which have grown up in the humus provided by the decay of the old tree. The name of dragon-tree, or dragon's-blood tree, is derived from the resin which exudes from the trunk, and is known as dragon's-blood, though the dragon's-blood of commerce is obtained chiefly from the *Calamus Draco*, an East Indian palm.

France.—*Action of the Induction-current upon Plants.*—M. Blondeau has pursued his investigation of the effect of the induction-current upon the vegetable organism (see our last Chronicle), by examining its action upon fruit and seed. Acting upon fruits the current hastens their maturity. Apples, pears, and peaches, which had been subjected to the action of the current, arrived at complete maturity when the other fruits of the same plant, which had not been operated upon, were still far from being ripe. The most curious results were obtained by electrifying seeds before placing them in the ground; seeds were rendered conductive by soaking them for some time in water, and then submitted for a few minutes to the action of the current. Peas, French beans, and wheat were experimented on. The electrified seeds always germinated sooner than those which had not been acted on by the current; the development of the plant was more rapid, and the stalks and leaves greener and more vigorous. Some of the electrified French beans presented a very curious peculiarity; they germinated downwards, the gemmule and cotyledons remaining in the ground, and the root rising into the air. The author remarks upon this peculiarity, which he compares to the effect of the current upon the poles of a magnet, and indicates that the embryo may hence be assimilated to a little magnet, having its neutral line and its two poles each charged with a peculiar fluid, tending to cause its organs to grow towards the centre of the earth or towards the sky. (!)

Green Rotten Wood.—Mr. Berkeley says in his 'Outlines of Fungology,' that "when wood is impregnated with the spawn of *Peziza ærugniosa*, it assumes a beautiful green tint. This is applied to various ornamental uses by the turners of Tunbridge Wells. Few people who admire it when manufactured are probably aware to what it owes its attraction." A writer in the 'Student' quotes this in reference to a colouring matter which has recently been obtained from rotten wood by two French chemists, and which evidently is what Mr. Berkeley alludes to, although they appear to be quite ignorant of its origin. M. Fordos found it to be soluble in sulphuric and nitric acids, and to be precipitated without alteration by water, and called it Xylochloric acid. M. Rommier, on the other hand, finds that, like indigo, it dissolves in alcohol (85° strength) in presence of potash and glucose, and the solution, which is at first brown, becomes green on contact with the air, and soon deposits the colouring matter in a gelatinous form. Silk and wool are easily dyed with it by adding acetic acid to an aqueous or ammoniacal solution of the colouring matter, steeping the thread in it and heating the solution to 80° C. M. Rommier calls this colouring matter Xylindeine. It is not stated whether an examination has been made with the spectroscope. It would certainly be very desirable to ascertain whether there are definite absorption bands or not. Has it any relation to the colouring matter, Phycocyan of Cohn, of which we have spoken here before?

Italy.—*Artificial Hybrids among Cotton-plants.*—M. J. E. Balsamo found from experiments tried in the province of Terra d'Otranto in the South of Italy, during the American war, that the Siamese type of American cotton-plants, *viz.* the Louisiana and New Orleans, flourished well in that district, whilst the more valuable Sea Island or long-staple cotton was rendered valueless by the autumn rains. The cotton-trees which have been cultivated from time immemorial in the southernmost part of Italy are the *Gossypium herbaceum* and *G. hirsutum*, and these M. Balsamo thought might be advantageously supplanted by the American cotton-tree (*Gossypium barbadense*), if only the long-staple form could be made to ripen at a more convenient period. Accordingly he endeavoured to obtain hybrids between *Gossypium hirsutum* and *G. barbadense*, and has succeeded so far as to present specimens of the hybrids to the French Academy. Each species of cotton-tree has five petals and a great number of monadelphous stamens, all bearing anthers, and surrounding the pistil at different heights. They seem to be so many radii implanted obliquely upon the central cylinder or bundle formed by the styles. There are as many styles as stigmata, and they may easily be separated with the point of a penknife. They may be recognized by the naked eye in the form of three, four, or five delicate nervures, united together on the inside. The number of cells in each capsule invariably corresponds to that of the styles;

it is therefore of importance to select the capsules which have the greatest number of cells, in order to obtain a greater number of tufts of cotton. The oblique position and nearly radiating arrangement of the stamens renders artificial fecundation difficult, in consequence of the difficulty of cutting them all down to the bottom of the calyx, and removing them without the falling of a little seminal dust upon the stigmata. Nevertheless M. Balsamo succeeded in avoiding the contact of the anthers, and in transporting the pollen to the pistil of the flowers from which he had removed all the stamina. The cotton-flowers open about noon and close up again after fecundation, the stamina acquire a more vertical position, and the pistil lowers its stigmata towards the stamina which are beneath it; the corolla changes from yellow to rosy red, and on the following day it falls withered. If it happens to rain on the day of the flowering of the cotton-tree, the water which remains in the flower alters and blackens the pollen; in that case natural fecundation itself may fail, and the withered flower does not fall or falls very late.

Besides his experiments on artificial hybridization of cotton-trees, M. Balsamo has investigated the action of light on the germination of the seeds. He found by using a glass jar full of vegetable mould, that seeds exposed to the action of sunlight were greatly retarded in, if not entirely prevented from, germination. Seeds to which only yellow light had access were not affected.

Germany.—*The Origin of Bacteria.*—A German lady, Frau Lüders, of Kiel, has been investigating this matter with the microscope, and has published her conclusions in Schultze's 'Archiv.' Her paper is one of very great interest, and her researches have been ably and carefully conducted. She believes that she has proved—what many fungologists were prepared for—that Vibriones (leaving aside the question of there being more than one species) are produced from the spores and germinal filaments of various moulds or fungi—amongst which are enumerated Mucor, Penicillium, Botrytis, Torula, Manilia, Aspergillum, Leptosporium, Arthrobotrys, Acremonium, and Verticillium. It is impossible here to give an account of the precautions adopted in growing these fungi, but they appear to have been satisfactory. Professor Hensen, of Kiel, strongly supports all Frau Lüders says. She is also induced to believe that the blood of living animals contains *Vibriones*, either in the catenated form, or in that of the constituent granules; but during life, and until putrescence commences, these are always quiescent, and show no signs of active existence. In support of this, the following experiment by Professor Hensen is quoted. The extremity of a glass tube bent in the form of a **W**, with the ends drawn out and quite closed, and which had been exposed for half-an-hour to 200° C., was thrust into the heart of a recently killed guinea-pig, and then broken off. After the blood had sucked into the tube from the other end, which

was melted off in order to remove any fluid that might adhere from the lips, the ends of the tube were sealed, and it was kept at a temperature of from 13° to 15° C. From one of the several tubes thus prepared, the point was removed after two days, and a drop of blood expelled on the next day, which, when examined with the microscope, showed large quantities of fungus-granules, chains and rods; mobile rods were rare. Milk, eggs, the mouth, and many organic fluids contain vibriones in this condition. Though Professor Hallier, the greatest authority on microscopic fungi, does not accept Frau Lüders' results as to the connection of "moulds" and "vibriones," yet her researches on the blood have great importance in connection with his own. Professor Hallier has recently announced that he has been able to isolate and identify from the blood of typhus-fever patients a distinct form of fungus; also in vaccine matter and in other cases. Dr. Salisbury, of New York, has also recently made known the observation of distinct fungi in the fluids of persons suffering from other contagious diseases. Are we not advancing to a great fact as to the nature of such diseases? Fermentation and vaccination may come to mean much the same thing. Frau Lüders has also successfully shown that "yeast" may be grown from many "moulds," as first demonstrated by Hallier.

5. CHEMISTRY.

(*Including the Proceedings of the Chemical Society.*)

Among the papers calling for prominent notice in this Chronicle, the first place is due to the Researches on Vanadium, an account of which was given by Dr. Roscoe in his Bakerian lecture before the Royal Society. The metal to which the name Vanadium has been given was first discovered by Del Rio in 1801. That chemist was, however, persuaded that the substance he had in hand was Chromium, and the new metal was again overlooked, until rediscovered by Sefström in 1830. Having hitherto been found in very small quantities, few chemists have had the opportunity of studying the metal and its compounds, and our knowledge of them is consequently limited. Almost all we know of them is, in fact, derived from the writings of Berzelius, whose conclusions have seldom been open to dispute. The remarkable exception, however, which vanadium compounds offer to the law of isomorphism, if the views of Berzelius are accepted as correct, has greatly puzzled chemists, who were more ready to admit an exception to a law, than to suppose an error in an analysis by the "solemn Swede." But it follows from the researches of Dr. Roscoe that what Berzelius took for the metal vanadium is really the monoxide, and that

the true formula of vanadic acid is $V_2 O_5$ (O=16). If this be correct, it follows that the vanadates form no exception to the law of isomorphism, and vanadium must be classed with phosphorus and arsenic. The atomic weight of the metal is necessarily corrected. Berzelius assigned to it the number 68·5 (O=8); but these researches prove that the true atomic weight is 51·21 (O=16). For a full account of Dr. Roscoe's investigations we must refer the reader to the 'Proceedings of the Royal Society,' No. 97, and shall here give only a short account of the oxygen compounds. The most interesting of these is the monoxide (Berzelius's metal), which Dr. Roscoe regards as a basic radical, and appropriately names it Vanadyl. It forms with chlorine a trichloride $V O Cl_3$, which Berzelius considered the terchloride of the metal. The monoxide is obtained when the vapour of vanadyl trichloride mixed with hydrogen is passed through a combustion-tube containing red-hot carbon. It is a grey powder possessing a metallic lustre. It may be prepared in solution by the action of nascent hydrogen on a solution of vanadic acid. After passing through all shades of blue and green, the solution acquires a permanent lavender tint, and then contains vanadium in the state of monoxide. The solution absorbs oxygen with great avidity. It bleaches indigo and other vegetable colouring matters as rapidly as chlorine, and far more powerfully than any other known reducing agent. Vanadium sesquioxide, $V_2 O_3$ (Berzelius's suboxide), is a black powder obtained by reducing vanadic acid in hydrogen at a red heat. This oxide has also a strong affinity for oxygen. When warmed in the air it glows and is reconverted into vanadic acid. At the ordinary temperature it absorbs oxygen slowly, and is changed into the dioxide, $V O_2$, forming blue shining crystals. Dr. Roscoe goes on to describe the constitution of the vanadates, and the compounds of vanadium with chlorine and nitrogen. We have no space for an account of these, and need only add, that these researches are in the highest degree creditable to their author.

In a practical point of view, recent researches offer to us but little of interest. We notice, however, a note by Mr. R. Warington, "On the Detection of Gaseous Impurities in Oil of Vitriol,"* which may be useful to our readers. These gaseous impurities are usually sulphurous acid and lower oxides of nitrogen. To detect the former, the author employs a strip of paper imbued with starch, and rendered blue at the time of using by immersion in a weak aqueous solution of iodine. In making the experiment, about two pounds of oil of vitriol are placed in a bottle, which it about half fills, and the bottle is violently shaken. The gases in the liquid are thus washed out by the atmospheric air, and if sulphurous acid

* 'Chemical News,' vol. xvii., p. 75.

be present, the strip of blue paper will be bleached when introduced into the air space of the bottle. The reaction in this case the author shows to be five times more delicate than the opposite one, when iodic acid and starch are used on the paper. To detect nitric oxides, Mr. Warington employs paper imbued with iodide of potassium and starch, which will be made blue by either of the oxides. Since, however, sulphurous acid destroys the blue iodide of starch, the presence of an excess of this gas will prevent the detection of the nitric oxides. But as these latter are without effect on the test paper employed for sulphurous acid, it is possible to obtain the reactions of both gases from the same oil of vitriol, if the sulphurous acid is not in excess.

Another paper of great practical value is that by Mr. W. Valentin, "On the Estimation of Sulphur in Coal Gas."* On few matters have greater discrepancies appeared in the reports of different experimenters than on this important question of the amount of sulphur in coal gas. Allowing that the quantity is very variable, these discrepancies admit of easy explanation. Still a process for its accurate determination is a great desideratum, and Mr. Valentin supplies one which has obvious recommendations. The gas, mixed with a proper proportion of atmospheric air, is passed through a porcelain tube, heated to redness by means of a combustion furnace. Within the porcelain tube is placed another tube made of fine platinum gauze, and filled with spongy platinum, and then a short platinum tube about four inches long, containing a few grammes of pure soda-lime. As the mixture of gas and air passes through the heated spongy platinum the sulphur compounds are completely oxidized, and the sulphuric acid (or the greater part of it) is fixed by the soda-lime as sulphate of sodium and calcium. The little that escapes may be fixed by causing the products of combustion to pass through a flask containing a solution of pure caustic soda. For the complete details respecting the operation, we must refer our readers to the place indicated below, with the remark that a process for estimating sulphur in gas is quite secondary in importance to one for removing sulphur before the gas reaches the consumer.

Another paper worthy of notice, is one by Mr. J. Hargreaves, "On the Manufacture of Steel from Cast Iron by the use of Nitrates and other Oxidizing Agents."† The subject of this paper, however, belongs properly to our Metallurgical Chronicle.

In organic chemistry a vast number of papers have been published which only possess interest for the advanced chemist. We may notice, however, the reported conversion by Siersch of methylic into ethylic alcohol‡ as a novelty of general interest.

The researches of Dr. Thudichum on the "Colouring Matters

* 'Chemical News,' vol. xvii., p. 89.
† Ibid., vol. xvii., p. 20.
‡ 'Ann. der Chem. und Pharm.,' Jan., 1868.

of the Bile and Urine"* also deserve a notice for the vast amount of labour which seems to have been bestowed upon them.

Among new chemical literature, we notice with pleasure the first publication of the Berlin Chemical Society.† This society was founded by Dr. Hofmann, upon the pattern of the London Chemical Society, and this record of the earliest communications made to it gives the promise of a great success.

This paper cannot be concluded without a brief reference to the losses chemistry has sustained within the last three months. It may seem an anachronism to place first on the list the name of Dr. John Davy, F.R.S., for he gave up the active pursuit of the science very many years ago. Still his connection with his more eminent brother at the Royal Institution, and the great promise of success contained in his early writings on chemistry, make this perhaps the most fitting place for a short record of his life.

Dr. Davy was born at Penzance, on the 24th of May, 1790, and was the youngest of five children, of whom Sir Humphry was the eldest. In the autumn of 1808, the subject of our notice came to London, and began the study of chemistry in the laboratory of the Royal Institution. The pupil was in a very short time advanced to the position of assistant to Sir Humphry, then in the zenith of his fame and happiness.

Within the period 1808–1811, the elder Davy, it will be remembered, made some of his most brilliant discoveries; and the younger brother was associated in all the laborious researches which led to them. Among these was that elaborate investigation which confirmed the views of Scheele as to the simple nature of chlorine. The name oxymuriatic acid, which until then was applied to that body, expressed the belief that it was a compound gas containing oxygen. The experiments of Sir Humphry Davy proved beyond a doubt that no oxygen could be separated from the so-called oxymuriatic acid; but they did not suffice to convince all the chemists of that day. Among those who remained unconvinced was Dr. Murray, the Lecturer on Chemistry at the University of Edinburgh; and it was in reply to the objections of this gentleman that Dr. (then Mr.) John Davy published his first scientific paper. It will be found in 'Nicholson's Journal,' vol. xxviii. (1811), and may be read with pleasure at this day for its lucid style and clear reasoning. This paper won the approval of Sir Humphry so much that he flatteringly told his brother he had never written anything half so good at the same age. The controversy went on for a couple of years, and led eventually to the discovery of Phosgene Gas, or chloro-carbonic acid, by Dr. Davy. In trying to repeat an experiment indicated by Dr. Murray, he exposed to sun-

* 'Proceedings of Royal Society,' No. 97, p. 215.

† 'Berichte der deutschen chemischen Gesellschaft zu Berlin,' N. 1, 2, 3.

light a mixture of equal volumes of chlorine and carbonic oxide, and found condensation to one volume take place. This induced him to make a complete examination of the new compound, an account of which is published in the 'Philosophical Transactions' for 1812. It was followed in a short time by two other papers, one "On the Compounds of Chlorine with the Metals," and another "On Certain Compounds of Fluoric Acid." These papers exhibit great diligence in research, and are marked by great accuracy in the analyses.

Here, we regret to say, Dr. Davy's career as a chemist may be said to have almost closed. He resolved upon the study of medicine, and proceeded to Edinburgh for the purpose. After taking his degree, he returned to London in 1814, and held for a short time the lectureship on chemistry at Windmill Street School of Medicine, vacated by Mr. Brande, who had been appointed Sir Humphry's successor at the Royal Institution. He delivered only one course of lectures, and we do not find any record of original research during this time.

Early in 1815, Dr. Davy entered the medical service of the army, and served as hospital assistant in the Waterloo campaign. He was afterwards sent to Ceylon, and served with Sir R. Brownrigge during the rebellion. The 'History of Ceylon,' which he published in 1819, is still referred to as authoritative.

Dr. Davy left Ceylon in 1820, and in the years which followed was employed in various parts of the world as staff army surgeon. He was doing duty in this capacity at Malta, when he was summoned to attend his brother in his last illness, which ended at Geneva.

Wherever he was, Dr. Davy was never idle. While a student at Edinburgh, he had commenced researches on the blood, which he continued at every possible opportunity. While at Malta, he was also engaged in some anatomical investigations, and made some experiments with the torpedo, in which he obtained some new results, showing the identity of the effects of its electrical organ with other forms of electricity. Nor was chemistry altogether neglected. At this time he examined the compounds of ammonia and carbonic acid, and made experiments on the oxidation of phosphorus. The results obtained were published in Jameson's 'Edinburgh Philosophical Journal,' which also contains a short paper, written about the same time, on silicated fluoric acid.

From 1835 to 1839 Dr. Davy was principal medical officer at Fort Pitt, Chatham, and then found time to write the 'Life of Sir Humphry,' published in two volumes. This work was called into existence by the appearance of another biography of the great chemist, "not gentlemanly done," as Sir Walter Scott said. The work referred to is now forgotten, and it is well to say that a very full biography of Sir Humphry Davy is to be found in the smaller

compass of a single, the first, volume of the eight volume edition of his works by Dr. Davy.

In 1839 Dr. Davy again left England to undertake the hopeless task of reforming the Turkish hospital system. A tour of inspecting service in the West Indies during the years 1845–8 terminated his active professional career, and he retired to what to most men would have been well-earned leisure at Ambleside. But leisure with Dr. Davy only meant time to occupy himself with his favourite pursuits; and up to the period of his last illness he continued an active investigator of facts, and a writer of papers and of books. A mere catalogue of the subjects of his investigations, and the titles of his papers and books, would occupy too considerable a space. We may mention three, however,—a second series of "Anatomical and Physiological Researches;" another entitled "Army Diseases, with Contributions to Pathology," embodying the results of his experience as an army physician; and the "Fragmentary Remains of Sir Humphry Davy," from which, as having been published in his later years, and including many of his earlier papers, an adequate knowledge may be gained of the various fields of labour upon which he entered.

One of his latest publications was a successful vindication in the 'Philosophical Magazine' of Sir Humphry Davy's reputation from certain assertions made by Mr. Babbage. In this task he was assisted by the late Sir James South. His very latest paper, "On the Temperature of the Common Fowl," was read before the Royal Society of Edinburgh a few weeks after his death. The subject of animal temperature occupied him more or less the greater part of his life. Wherever he happened to be, he was busy with his thermometer, which found its way into the mouths of all sorts of animals, including the tiger, the leopard, the Indian elephant, the shark, and the adder.

Dr. Davy was seized with his last illness on January 15th, and died on the 24th, at the advanced age of 78. His first paper was published in 1811, his last this year. Thus his activity as an experimenter and author is seen to have lasted over fifty years. We have before expressed our regret that he did not confine himself to the study of chemistry. Anatomists and physiologists will probably regret that his attention was not concentrated on their sciences. He was, indeed, calculated to shine in any pursuit that requires patient and laborious investigations, for therein lay his strength. For mere hypothesis he had small respect, but spoke in praise of theories which in his first paper he defined as "generalizations upon observed facts." He made it his business, however, to observe the facts, and we may rest assured that he who generalizes upon the observations of John Davy has a safe foundation. Such as he are the men who really advance science.

XUM

Mr. Wm. Herapath, F.C.S., died at Bristol on the 13th of February, in his 73rd year. Although a sound general chemist, he was best known as a toxicologist, having been brought into notoriety by the celebrated Burdock case, some thirty years ago. He was one of the founders of the Chemical Society, and Lecturer on Chemistry at the Bristol Medical School.

Proceedings of the Chemical Society.

The first meeting we have to notice was held on December 19. On that evening Mr. A. Tribe read a paper "On the Freezing of Water and Bismuth." Bismuth, it has been said, is a body which, like water, expands near the point of solidification. The author's experiments prove that although the metal does increase in bulk at the moment of solidification, there is no evidence to show that any expansion takes place before the solidification.

At the meeting on January 16, a paper by Mr. Pedler "On Isomeric Forms of Valeric Acid" was read, in which the author showed that the acid prepared from inactive amylic alcohol—*i.e.*, the alcohol which does not affect the plane of polarization, is also inactive towards a polarized ray, while that prepared from the active alcohol rotates the ray 43° to the right.

After this, Dr. Debus made a verbal communication "On Thioformic Acid," an acid produced when formiate of lead is treated with sulphuretted hydrogen. The views expressed were of a hypothetical nature; but the speaker promised some investigations on the subject.

Dr. Frankland then delivered a lecture "On Water Analysis." In this lecture, the author first gave a critical review of the methods commonly employed for the determination—1, Of the total solids; 2, the organic and volatile matters; 3, the amount of oxygen required to oxidize the organic matter; 4, the nitrites and nitrates; and 5, the ammonia.

1. To estimate the total solid constituents, it is usual to evaporate a measured quantity of the water with the addition of a known amount of carbonate of soda, and to dry the residue at from 120° to 130° C., until the weight is constant.* In this process the lecturer pointed out two sources of error. In the first place, if salts of ammonia are present, they are changed into carbonate, which is volatilized; and, in the second place, urea will also be decomposed, and some of its products dissipated. An experiment

* Dr. Frankland was in error in ascribing the first employment of carbonate of soda to Messrs. Hofmann and Blyth. The method was adopted by those gentlemen in the examination of the London waters (1856); but was first employed by Mr. Edwin Schweitzer.

showed that as much as 44 per cent. of the urea might be lost in this way. These two sources of error may be avoided by leaving out the carbonate of soda, evaporating at a low temperature, and drying at 100° C. A little water will be left behind in this way, but it will be chemically combined, and may be fairly considered part of the solid constituents. The differences of weight in residues dried at these different temperatures was shown by a few examples. Thus, a residue which dried at 100°, weighed 27·02, when heated to 120°—130°, weighed 26·54. Another, dried at 100°, weighed 26·70, and at 120°—130°, 26·20. Before, however, a residue is ignited to determine the organic matter, the water must be expelled by carrying the heat to the higher temperature.

2. To determine the organic and volatile matters, the residue is heated to dull redness. By this the carbonates of lime and magnesia are causticized, and must be recarbonated by means of carbonic acid water; the addition of which, and the redrying must be repeated until the weight of the residue ceases to increase. In this process there are also two sources of error. The organic matter may not be entirely destroyed. When, for example, urea is evaporated with sodic carbonate, the loss on ignition represents but a small part of the urea in the original residue. Sometimes also after recarbonating an ignited residue it weighs more than before ignition. In any case a loss on ignition may represent organic matter, or it may represent mineral nitrites and nitrates, while the organic matter may remain.

3. To ascertain the amount of oxygen required to oxidize organic matter, a solution of permanganate of potash is employed. This process Dr. Frankland said is utterly untrustworthy, many organic substances refusing to be completely oxidized by this means. In the cases of urea and hippuric acid, for example, the oxygen consumed represented only one-fiftieth of that required by theory.

4. To determine nitrous and nitric acids, Dr. Pugh's method has been generally followed, but Messrs. Chapman and Schenck have shown that many organic substances affect the result.

5. To estimate ammonia the water is usually distilled with baryta or carbonate of soda, and the ammonia determined in the distillate either by neutralization or Nessler's test. When, however, urea is present, ammonia may be liberated, which will be estimated as free. After this criticism of the usual processes, Dr. Frankland made some suggestions for their improvement. To determine the amount of solid ingredients, he recommended that half a litre, or a litre, of the water should be evaporated as rapidly as possible, and the residue dried at 100°. Our space will not allow us to describe the particular manner by which Dr. Frankland determines the amount of organic carbon and nitrogen from which he deduces the amount of organic contamination. We may say

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briefly, however, that the determination is effected by a combustion of the fixed residue after the expulsion of the carbonic, nitrous, and nitric acids, by the addition of sulphurous acid. For a full description, we must refer our readers to an excellent report in the 'Chemical News' for February 14, and the 'Journal of the Chemical Society' for March.

For an account of Mr. Crum's process for the determination of nitric acid, which is adopted by Dr. Frankland, we must refer our readers to the same places, or to the original paper, "On the Analysis of Bodies containing Nitric Acid" in the 'Philosophical Magazine,' vol. xxx., 1847.

Lastly, for the determination of the ammonia, Dr. Frankland employs Nessler's test with the original water, decolorized, if necessary, by the addition of a little chloride of calcium, carbonate of soda, and a few drops of potash.

The lecture was followed by a very long discussion, which turned mainly upon the value of the process of Messrs. Wanklyn, Chapman and Smith for estimating albumenoid nitrogen in waters. (See 'Q. J. S.,' vol. iv., p. 532.) We believe we state fairly the general opinion, when we say that the value of the process is considered doubtful, scarcely two experimenters obtaining concordant results with it. The discussion occupied the greater part of two evening meetings.

At the meeting on February 6, Dr. Russell gave a lecture "On Gas Analysis," in which he described a greatly improved and simplified form of the apparatus he devised some years ago. A description and drawing of the original apparatus is given in the 'Chemical News,' vol. ix., p. 282; and an account of the improvements now made are contained in the same journal, vol. xvii., p. 95.

Mr. W. H. Perkin, F.R.S., afterwards read a paper "On some New Benzylic Derivatives of the Salicyl Series."

At the same meeting the Secretary read a short note from Professor Kolbe, announcing the discovery by Dr. E. Drechsel of a means of *reducing carbonic to oxalic acid.* A mixture of pure sodium and dry sand is placed in a flask, and heated to the boiling point of mercury. A current of carbonic acid is then passed. After some time the metallic appearance of the sodium is lost, and the metal becomes almost black. The heat is then moderated to avoid reduction of the carbon, and the mass is allowed to slowly cool. When the mass is afterwards extracted with water, the solution is found to contain oxalate of sodium. Potassium amalgam it has been found will effect the same reduction.

Dr. Frankland described this discovery as one of the greatest triumphs of modern synthetical chemistry.

On February 20, Mr. David Forbes, F.G.S., delivered a lecture "On Chemical Geology," which attracted a large audience. An adequate report of this highly interesting discourse, and the dis-

cussion which followed its delivery, could hardly be given in the small space we can devote to the matter; and we shall only say that Mr. Forbes considers that a combination of the Plutonic and Neptunian theories will best account for the results developed by modern research. He showed that silica occurred in nature as an igneous product in recent lavas; that it occurred also as an aqueous product in different forms deposited from solution; and also as a gasolytic product in tubes from the decomposition of fluoride of silicon. As regards the origin of granites, while he is satisfied that many of the so-called granites and gneisses are really sedimentary products of the breaking-up of true igneous rocks by aqueous agency, and subsequently reconsolidation, he also believes that true igneous and eruptive granites do exist, and he replied at some length to the arguments of those who dispute altogether the igneous origin of these rocks. Assuming that the whole of the constituents of this earth were once in a state of vapour, he considers that these vapours obeyed the law of gravity and arranged themselves in zones according to their densities. He thus concludes that the central nucleus of the earth must contain an accumulation of the denser metals and their compounds, an hypothesis which is supported by the fact, that while the mean density of the earth is about 5·4, the density of the exterior crust is only 2·75. At the moment of solidification the earth must have formed a true sphere; but the outer crust becoming subject to volcanic and other forces, the surface would be soon broken up into mountains and valleys, and subsequent aqueous action would produce other changes in the first-formed rocks. Metamorphic action, promoted by heat, pressure, chemical action, aqueous or gasolytic agency, or altogether combined, would continue to go on, and produce that state of our earth which offers itself for the study of the modern geologist. The discourse, of which the foregoing is the merest outline, was followed by a discussion, in which Sir R. Murchison and Professors M'Donald and Morris took part. For an excellent report of this we may refer the reader interested in the matter to the 'Chemical News' for February 28.

The last meeting of the Society which we can notice was held on March 5. On that evening Professor Wanklyn gave the substance of a paper "On the Action of Oxidizing Agents on Organic Compounds in the presence of an excess of Alkali—Part 1. Ammonia evolved by Alkaline Permanganate, acting on Organic Nitrocompounds."

The paper related to the author's process, before referred to, for determining the amount of nitrogenized organic matters in waters; and he gave a list, first, of the substances which he found to yield all, or very nearly all, their nitrogen in the form of ammonia, when distilled with permanganate of potash in the presence of free alkali. Among these were amylamine, diamylamine, asparagine, hippuric

acid, piperine, and narcotine. Next followed a list of substances which yielded about half of their nitrogen under the same circumstances, among which we have morphia, codeia, papaverine, sulphate of quinine, and nicotine. Kreatine is an example of a substance which gives up one-third of its nitrogen as ammonia, while theine only yields one-fourth. Gelatine, casein, and dry albumen give up smaller, and apparently uncertain proportions; while picric acid and true nitro-compounds give up none.

Mr. E. T. Chapman then read a note "On the Decomposition of Nitrates by Sulphurous Acid; and another "On the Detection and Estimation of Nitrates in Potable Waters." The estimation the author makes by converting the nitric acid into ammonia, by the action of aluminium and an alkali. The limits of error by the process he believes to be within five per cent.

Mr. Perkin, F.R.S., afterwards read a paper "On the Hydride of Aceto-salicyl," which was followed by two by Dr. Stenhouse, F.R.S., "On Chloranil," and "On the Action of Nitric Acid on Picramic Acid." Lastly, Mr. Chapman gave a short account of the "Action of Zinc Ethyl on Nitrous and Nitric Ethers," which is, it seems, sometimes attended with very violent explosions.

The Secretary also read papers by Mr. Hunter, "On the Absorption of Vapours by Cocoa-nut Charcoal," and by Mr. F. A. Claudet "On the Crystalline Form of Arsenious Acid." The author had obtained from the Pyrites Mine of San Domingos, Portugal, a quantity of fine crystals, similar in form to those first described by Wöhler, as obtained by sublimation under peculiar circumstances. The crystals belong apparently to the same system as those of gypsum. This form cannot be reproduced by either solution or sublimation, in either case only the ordinary octohedral crystals being obtained. There are reasons for believing that active spontaneous combustion is going on in a part of the mine mentioned, and the arsenious acid was probably sublimed in an atmosphere of sulphurous acid.

6. ENGINEERING—CIVIL AND MECHANICAL.

Whilst the fear engendered by the late collapse of several railway and other companies still exercises its influence on capitalists, causing the suspension or abeyance of numerous promising undertakings in Civil Engineering, the combinations of mechanics, under the influence of Trade Societies, is rapidly having the effect, not only of disturbing the relations between employers and employed, but of diverting trade from its former centres, and in too many instances of driving it out of the country. Of this latter result, numerous examples might be instanced; but perhaps the most

remarkable of all that have come to our knowledge is the fact of a Preston mill owner having recently obtained spinning machinery from Belgium.

Shipbuilding, Docks, Piers, &c.—Iron shipbuilding is beginning to show symptoms of recovery from its recent depression at most parts except London, where the suicidal combinations of workmen effectually prevent builders from taking orders. On the Clyde and Tyne a fair amount of business has been done during the past year. On the Mersey most of the shipbuilders are tolerably busy, and at Messrs. Laird's yard two or three ironclads are under construction. A new paddle steamship, for the City of Dublin Steam Packet Company, was launched at the end of November last from the yard of Messrs. Walpole, Webb, and Bewley, of Dublin. This is worthy of note, since it is the first vessel of that class hitherto constructed at Dublin. M. Giquel, a Frenchman, is stated to have arrived at Tientsin with one hundred French engineers and workmen, where he is about to build sixteen steamers, of 300 tons each, for the Imperial Customs. A new iron steam ferry-bridge has recently been constructed for the Govan Ferry, which carries two loaded waggons or three loaded carts, together with sixty or eighty passengers; with these it crosses the Clyde in 1½ minute. This vessel is constructed in six water-tight compartments. The machinery for propulsion consists of a pair of 20 horse-power diagonal steam-engines, geared to the driving wheel, round the circumference of which is wound the driving chain, whose ends are secured on each side of the Clyde.

During 1867 about 350,000 cubic yards of earthwork and 24,000 cubic yards of masonry and brickwork were executed at the Hull Western Dock; and it is the opinion of Mr. Hawkshaw that, if due diligence be shown, the dock may be completed this year. The Hull Graving Dock is to be increased by 83 feet, which will give it a total length of 300 feet; the depth is also to be increased to the extent of 4 feet 6 inches. From the report of the engineer to the Mersey Docks and Harbour Board, it appears that the amount required to complete works in progress and contemplated is upwards of 700,000*l*.

A new pier has recently been ordered to be erected in Woolwich Arsenal, to facilitate the shipment of heavy ordnance, which will be fitted with cranes capable of hoisting 30 tons weight. The pier with its T head will extend 300 feet towards the bed of the Thames; it will be 25 feet broad, and the head of the pier will be 100 feet long. A new wrought-iron pier is in course of construction at Clevedon, in Somerset; the length of the approaches is 180 feet, and of the pier itself 800 feet, having a head 42 feet in length, making a total length of over 1,000 feet. The pier is composed of eight 100-feet spans, consisting of two continuous

wrought-iron girders, 3 feet 6 inches deep, which serve partly to form the parapet. The pier head measures 42 feet by 50 feet, and is supported on eighteen piles, standing 65 feet in height above the ground. A new pier is about to be carried out at Saltburn-by-the-Sea, and a contract for the ironwork has been taken by Messrs. Cochrane, Groves, and Co., of the Ormesby Ironworks. Some time ago a premium was offered for the best design for the protection of the headland at Hartlepool, and we now learn that the plans and estimates of Mr. Thomas Fenwick, C.E., of Leeds, have been selected.

A swing bridge has recently been erected over the river Hull, near its junction with the river Humber. The bridge consists of two parts, namely, a movable part on the eastern, or citadel, side, which, when open, gives a clear waterway of 100 feet; and a fixed part on the western side, having a clear space of 40 feet. The London and North-Western Railway Company have been making good progress with their great bridge over the Mersey at Runcorn; the sixth and last great girder is placed, and traffic is expected to be commenced over the bridge in June next. The scheme for bridging the Forth at Alloa was fairly set afloat on 3rd January last; the structure will be similar to that across the Tay at Perth, having spans of 64 feet in width. In the centre the bridge will swing from both sides and open a space of 200 feet for vessels to pass through. A bridge has been thrown across the Boug, on the Balta and Olviopol Railway, which is 800 feet in length, and contains 1,640 tons of iron in its structure. The Perkiomen Railway Bridge, to be constructed across the Schuylkill, will consist of three spans of 170 feet, and one span of 125 feet, and having a total length of 635 feet. It is to be built on the plan known in America as the "isometrical truss."

Lighthouses.—A novel sort of lighthouse has recently been erected at Lowestoft. In consequence of the tendency of the foreshore to move steadily in a fixed direction, the design has been so arranged that the structure may be easily removed; and for this purpose the superstructure has been made independent of the bearing-piles and foundation-frame. The height from the level of high-water spring-tides to the centre of the lantern is 40 feet, and the illuminating apparatus is a second-order dioptric light by Messrs. Chance, Brothers, of Birmingham. The new lighthouse at Cochin, on the Madras coast, was inaugurated on the 15th January last. Two lighthouses have been erected by the Abyssinian Expedition at Assaike and Adjnee Island in Annesley Bay.

Railways.—The construction of the Sloane Square station of the Metropolitan District Railway involved, amongst other works, the destruction of a length of the Ranelagh sewer. The cast-iron tube, which has replaced the old brickwork, is supported on two

wrought-iron main girders, and on two smaller girders of cast-iron, which span the staircase constructed at the back of one of the retaining-walls of the station. The widening of the Metropolitan Railway between King's Cross and Farringdon Street stations was officially inspected, upon completion, on 15th January last. The widening commences in King's Cross station, and for some distance it runs parallel with the old line; then dipping, it crosses beneath the Metropolitan, and rising on the other side, again runs parallel with it. The covered way on the East London Railway is completed to within 200 yards of the Thames Tunnel, and the works to connect the covered way with the Tunnel are in progress. The embankment is nearly completed to the junction with the Brighton Railway, and from this point to the north bank of the Thames the line may be ready for traffic before the end of the summer. It is expected that the Sutherland Railway, extending from Bonar Bridge to Golspie, will be opened for traffic about the end of March. The Swansea section of the Llanelly Railway was opened for passenger traffic throughout on January 1st. By the opening of this section the narrow gauge has been completed from Swansea to Carmarthen, and, by means of the Central Wales line, the London and North Western system will now have direct access to the ports of Swansea and Llanelly. On Saturday, December 7th, an important step in the construction of the railway viaduct across the Solway Firth was accomplished by the meeting of the two portions which have been worked from the English and Scotch shores. The portion of the viaduct now completed, which was commenced about two years ago, is about a mile in length, consists of 183 piers, and has a height of about forty feet above low water. The three large bridges on the Callander and Oban Railway, and which span the Teith three times between Callander village and Loch Lubnaig, are now finished. The middle one, which is at the Pass of Leny, is 140 feet span, and the others are within a few feet of the same length.

The progress of the Mont Cenis tunnel in December last was 73·25 mètres in length; 35·40 mètres having been pierced on the Italian side, and 37·85 mètres on the French side. Up to 31st December last 7,846·65 mètres had been excavated, leaving 4,373·35 mètres still to be done. The Summit Railway over Mont Cenis still hangs fire, and has not yet been brought into use, although it was officially opened some months since. It is now, however, given out that it will commence regular work on 1st May. Meanwhile, the railway over the Brenner seems to be acquiring popularity as a means of transit from Western Europe to Italy. On the Ligurian line of railway the Porto Vado tunnel, 1,200 mètres in length, is nearly finished, as is also the section of railway between Vado and Sportono.

The second section of a line of railway from Moscow to the south has been opened for traffic. The first section from Moscow to Serpoukhoff, 59⅜ miles, was opened for traffic in 1866, and the section now opened extends from Serpoukhoff to Toula, 59⅛ miles; traffic is thus now conducted over a distance of 117½ miles. The third section, between Toula and Orel, and the fourth, from Orel to Koursk, will be opened to the public next summer. The Ryason-Morschausk line, a portion of the Moscow-Volga line, has also been recently opened; it is 150 miles long, and has only taken a year and three months to construct. The Koslow-Woronesh Railway, a link in the long line to be laid down between Moscow and the Sea of Asof, is probably by this time completed. The Moscow-Odessa line is progressing so fast that it will most likely be completed this year; and the works between Poti and Tiflis, a line which, after its extension to the Caspian harbour of Baku, will monopolize a considerable portion of the Persian trade, have just been begun.

The Ciudad Real and Badajoz Railway Company completed its branch line to the Belmez coal-basin in January last. This result is expected to have an important influence upon the original undertakings, as it will not only lead to the development of a coal traffic, but will also assist in the reduction of working expenses.

The railway tunnel at Constantia, in Algeria, is finished. It is nearly 3,000 feet long.

The first half of the experimental elevated railroad in Greenwich street, New York, is fast approaching completion. The Pacific Railroad is now stated to have been carried 520 miles beyond Omaha; more than 4,000 men are employed on the earthworks and the construction of rolling stock. An unbroken railway communication is now open from the Atlantic seaboard to the Rocky Mountains, a distance of more than 2,000 miles. An additional railway section has just been opened for traffic in Chili.

The doubling of the Great Indian Peninsula Railway between Egutpoara and Nassick was expected to be finished by the end of last year. Plans and sections of the Neemuch and Delhi extension of the Bombay, Baroda, and Central India Railway, from Saugor to Nusseerabad, have been completed, as has also the survey to Jeypore, a section of which is about to be started, and another party is working towards Agra. The extension of the same line to the river Saburmuttee, at Ahmedabad, a distance of 2¼ miles, will shortly be commenced. The railway bridge over this river, which was designed by Mr. A. W. Forde, formerly Chief Engineer of the Bombay and Baroda Railway, has been let to that gentleman for 4½ lacs of rupees. The opening of the Chittravutty Bridge on 8th January last, together with the completion of the Madras and Bombay Railway to Tadpatri, will have the effect of opening up the

important district of Bellary. This bridge is 2,800 feet long, or a little over half-a-mile; the end girders are supported on masonry piers, and in the centre on wrought-iron screw piles.

River Improvements and Canals.—In order to avoid any disastrous flooding of the River Irwell, Mr. Hawksley, C.E., recommends the construction, at a cost of 120,000*l.*, of a tunnel, 2 miles long and 10 yards in diameter, for the purpose of carrying off the superfluous water.

The works for improving the Godavery have made such progress that it is anticipated the river will be open for navigation as far as the second barrier, 225 miles from the sea, before the next monsoon. Works have been commenced for the construction of a new canal from the Sutlej; it will leave the left bank of the river near Roopur, and, passing southwards, will irrigate the arid parts of Puttiala, Ferozepore, and Sirsa. The Grand Canal, in China, which has been gradually drying up since 1857, has now become utterly impassable, vessels drawing a few inches only being unable to find water to float them. A project for a canal for the irrigation of Lombardy by water, from the Lago Maggiore, has recently been brought forward.

Mechanical.—A series of experiments have recently been carried out in London on a new form of furnace invented by Mr. T. J. Leigh. This furnace is applicable for puddling, steel-melting, or other purposes for which an intense heat is required, and it is adapted for burning slack coal as fuel, which is instantaneously converted into gas as it is fed in, and a perfect combustion and very intense heat are obtained. Crop ends of steel rails placed in the furnace are reduced to a perfect fluid state in 25 minutes, and wrought-iron is also readily melted. The Russian Government are making great efforts to develop the mechanical industry of that empire. The construction of a bridge proposed to be thrown across the Boug, on the Warsaw and Terespol Railway, has been let to a Russian house. The Russian Government also intends to order a quantity of plant —including locomotives and tenders—from four works on its territories; and it is further rumoured that the Government is disposed, where necessary, to stimulate Russian mechanical industry by direct pecuniary advances. We have already alluded to a consignment of spinning machinery from Belgium having recently been received at a cotton mill in Preston. As another instance of the successful competition of foreign manufacturers with our own, it may be stated that Alexander, of Barcelona, is now making marine engines of several hundred horse-power for a Liverpool firm.

7. GEOGRAPHY.

(Including the Proceedings of the Royal Geographical Society.)

Whilst attention is most earnestly directed to Africa, the Nile is not the source of this engrossing speculation. Dr. Livingstone is, as far as we know, progressing in a northerly direction for Nyassa, and solving the problems left by his predecessors in the neighbourhood of the great lakes. The information received that, some year or more back, he was alive and well, will be found in the latter part of this Chronicle, amid the Proceedings of the Royal Geographical Society. The main object of consideration at present is the small strip of land on the western shore of the southern part of the Red Sea, which forms the eastern slope of the highlands of Abyssinia. Here a small British force are doing work at the expense of the nation, which it usually falls to the share of the unpaid contributors to the Royal Geographical Society to perform. New passes have been discovered, and the whole of the water system of the district carefully surveyed. In the meantime the present state of our knowledge and our ignorance is accurately laid down in a cheap Blue Book, in which is collected almost everything known about this country previous to the landing of the expedition. The most valuable addition to our knowledge since that period is the report of Mr. Clements Markham, an abstract of which will be found at the end of this article.

The captives, from time to time, send letters, in which they approve of what is being done for their release. In the meanwhile the doubt still remains whether any Europeans are detained in the Somali country. An opportunity has offered of obtaining information on this point, but we do not know that the Government have availed themselves of the assemblage at Berbera, at the annual fair, of all the principal people from the whole of this eastern peninsula of Africa. It has been suggested that rewards for information, and greater ransoms for living men, would soon bring every European detained up the country to some point on the coast easily accessible from Aden.

The result of the appeal in aid of the Palestine Exploration Fund was the collection of a large sum, which will enable the work to be carried on for some considerable time, and it is to be hoped that many discoveries will be made, for undoubtedly much remains to be laid bare. Many ancient buildings must be simply covered with the accumulated rubbish of ages; and whatever may have been the will of conquerors for the destruction of the city, a great deal must be only hidden, to be brought to light, it is to be hoped, by the engineers now at work. At all events, the various levels of

different parts of the town are being discovered by shafts let down to the rocky foundations.

A great deal of careful investigation of the country through Nepaul and along the whole length of Thibet to Lhasa has been made by a pundit at the instance of Captain Montgomerie, R.E., who was prohibited by his official position from making the attempt himself. The country described, of which we shall probably soon get very full information, runs along the valley of the Brahmaputra almost from its source. The pundit had to travel in various disguises, but succeeded in carrying philosophical instruments with him, and in making a large number of accurate observations, thus settling both positions and elevations of many places. The road between Gartokh and Lhasa, a distance of 800 miles, is one of the most important features of the country. It passes the head waters of the Indus, the Sutlej, and the Brahmaputra, and continues to keep very closely to the line of the latter river. The Government couriers traverse it in twenty-two or twenty-three days, only dismounting to change horses and to pass rivers, never resting or changing their clothes, which are sealed on, and arriving at their journey's end haggard and worn, and eaten into sores by lice. The description of Lhasa, 11,400 feet above the sea, differs little from that of Huc and Gabet. The Grand Lama, whom the pundit saw, lives at a fort a mile from the town. He is a boy of thirteen, surrounded by priests, who show him every respect. He exhibited some considerable intelligence, but the government is entirely in the hands of the prime minister. Tea is imported in large quantities from the north-east, and musk is the principal article of commerce which finds its way into the Indian market.

The whole Chinese empire seems to be in a state of dissolution. Province after province has revolted. Rumours, with what foundation it is impossible to say, speak of defections on the western boundary. Russia, probably, will in time take advantage of this, and increase her already overgrown dominion. A survey has been made to discover the best route to the south-western part of China from Rangoon.

In this survey the country of the Karens, an independent tribe, has been traversed. The people are peaceable, but they appear to dread their neighbours, for they invariably flee as soon as strangers visit their villages. Paths are rare, and there is but little to mark that the country is inhabited, though it is extremely fertile. The custom seems to be to clear a piece of land, crop it until it is exhausted, and then abandon it for a new clearing. The most valuable product is the iron-tree, frequently rising 80 ft. straight upwithout a branch.

In New Zealand, the district of the Lower Waikato, to the south of Auckland, has been surveyed. It is a fertile country,

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suited for pasturage and roots, but not well adapted to corn, being covered with brush. The soil is of a loamy nature, but deposits of limestone and of a so-called "brown coal" are found. The limestone is fit for building, and for some finer work, and the coal has been used on the river steamers. The amount of the latter is considerable, and promises to be easily worked, without sinking shafts or difficulty from water.

In Australia, the exploration of the Gulf of Carpentaria has been continued by the expedition sent out by the Government of South Australia. Several hitherto unknown rivers, and a bay of 20 miles width by 10 broad, have been discovered on the north-western promontory of the Gulf. A large quantity of gold has been found on the Mary River, about 100 miles to the north of Brisbane, which, of course, has had a great effect upon the labour market.

In Europe, the greatest geographical event has been the eruption of Mount Vesuvius, with its attendant disturbances of landslips and earthquakes. In the midst of Naples itself, a portion of a cliff which overhung a main street slipped forward, burying houses and, it is said, even carriages in its fall. That the continued earthquakes have had something to do with this disaster there cannot be any doubt: how much is a question that cannot be solved at present. The eruption itself has now gone on for some considerable period. Part of the older crater has been broken away; a new cone has arisen; several streams of lava have poured down the sides, threatening in turn Resina, Torre del Greco, the Hermitage, and the Observatory. As yet, no great damage has been done to the cultivated lands; but the people of the neighbourhood have been prepared to flee at the first appearance of danger. The form of the mountain is considerably changed, and it has been covered at various times with sublimates of different salts, which are washed away by the rain, a new deposit soon taking the place of the old one. The mountain in the meanwhile has been a magnificent sight, especially by night. The streams of lava glow with various degrees of brightness, whilst that which appears a pillar of cloud by day is a fountain of fire at night. Continuous discharges of various characters accompany the earthquakes, which are so violent, that the instruments at the Observatory have to be detached from the walls, and laid on the ground. Professor Phillips, of Oxford, has gone to the spot to settle some points with regard to the deposition of lava.

The Gulf Stream is said to have become much more rapid since the disturbances in the West Indies. Changes in this current cannot but affect our climate. The subject of this stream has been carefully handled by J. G. Kohl, in his 'Geschichte des Golfstroms und seiner Erforschung.' Amongst the new works on Geography, either published or promised shortly, are 'Vambery's

Sketches of Central Asia,' Major's 'Life of Prince Henry of Portugal,' Chapman's 'Interior of South Africa,' Hochstetter's 'New Zealand,' Maurer's 'Die Nicobaren.'

Proceedings of the Royal Geographical Society.

At the first meeting of the Society this year a report was read from Mr. C. D. Young, who was present, and afterwards explained some points at further length, giving an account of the expedition sent to Southern Africa for the purpose of ascertaining the truth or the falsehood of the reported death of Dr. Livingstone. Mr. Young and his party landed at the mouth of the Zambesi, and pursued the course of that river past Senna to the Shire, which stream again was followed first to the Lake Panalombe and then to the Nyassa. The southern portions of this great lake were explored, and everywhere the same story was recounted by men hostile to one another, and willing enough to throw the blame of a white man's death upon their enemies. About a year previously a white man, recognized by several to be like a photograph of Livingstone, passed through the country on both sides of the Nyassa, travelling slowly towards the north-west side of the lake. The Makololo, the Ajawas, Mananjas, the Machinkas, some Arabs settled on the lake, all gave the same account. Mr. Young might have gone much farther, and explored a larger surface of the lake, had not his boatmen, Makololo, been afraid of the Mizitu, who had invaded the whole district of the Shire. Several articles given or bartered by Livingstone were produced; and there is no doubt that he is the white man who passed along the shores of the lake a year ago.

At the next meeting, Captain Sherard Osborn, R.N., read a paper on a subject towards which he has directed public attention before, and lately more particularly in a letter to the 'Times,' *viz.* "The Exploration of the North Polar Regions." Captain Osborn's argument is, that no better training exists for scientific purposes during peace than the dangers and trials of arctic navigation. A few years hence a party to observe the transit of Venus in ant-arctic regions will be required, and officers who have already served in similar regions will be the best adapted for making use of this rare opportunity of settling many moot questions in astronomical science.

M. Lambart in France, and Dr. Petermann in Germany, are inciting their fellow-countrymen to send expeditions to attempt to reach the North Pole; the former by Behring Straits, the latter by Spitzbergen. Englishmen have ever been the foremost in discovery in these regions, and it would seem hard indeed if some continental and unmaritime nation were to snatch the crowning discovery from the chief navigators in the world. There seemed

to be some difference of opinion in the Society as to whether the route by Smith's Sound is really the most practical, a difficulty fatal to any strong pressure upon the Government to send forth an expedition at the expense of the nation. So long as scientific men are divided as to the expediency of an expedition, or as to the best route to be observed, so long will mere politicians be able to withstand their importunities.

The reasons for the preference of Smith's Sound seem to be, that it is possible to travel far northwards along the coast, leaving depôts where necessary, until the open water believed to exist around the pole itself may be reached; whilst by both the other routes the journey will be by sea until the pack is met with which encloses the open water; this must be passed on foot, the explorers carrying boats with them until they come to a second sea, which must be traversed again in the small vessels which have been carried across the pack. Some authorities think the pack might be passed by well-built steam vessels, but anyhow whalers have penetrated nearer to the pole already by Smith's Sound than by any other route.

The most important papers read this Session were communications from Mr. Clements Markham, describing the physical geography of that portion of Abyssinia which has been visited by our troops. The country explored stretches along the coast from Zoulla to Howakel Bay, and includes the intervening peninsula; it then runs inland by the Tekonda Pass to Senafé, around which place a variety of expeditions have enabled Mr. Markham to form a good idea of the general character of the highland. A large river system, unknown to the maps, called Ragolay, runs from above Senafé towards the peninsula mentioned before, where, at some distance from the sea, the river is swallowed up in a salt plain, which is covered with incrustations caused by evaporation. This river appears to receive the drainage of all the eastern slope of the highlands; a circumstance that forms a fair argument for supposing that the floods, during the rainy season in the Senafé Pass, are not usually so great as they have been reported to be. The country adjoining the coast is a sandy plain, intersected by the dry beds of torrents. The tide rises usually about 4ft. 6in., a slight increase of which lays a considerable portion of the shelving plain under water. The mountains rise rather suddenly at a distance varying from 10 to 16 miles' distance from the coast. The passes are hemmed in by enormous boulders, or by perpendicular sides, first of gneiss, and farther inland of dark schistose metamorphic rocks, and these again are succeeded by sandstone. The rise extends for 46 miles, until at Senafé—7,464 feet above the sea level—the tableland is reached: but few natural passes in the world are easier than those that have by this time been traversed by our troops. The vegetation grows richer and more varied as an advance is made inland. Tropical trees and

plants are abundant in the valleys, whilst on the sides of Mount Sowayra ("Sowera" of Keith Johnston and of Wyld) sub-tropical, and then temperate, even English, vegetation is to be found; the latter ranges from 9,000 feet to 6,000 feet above the sea-level. Senafé is the boundary between the Mahometan and Christian inhabitants. The country seems fairly fertile, and a variety of animals afford employment for the naturalist. The whole of Mr. Markham's communication, of which the above is but a slight sketch, is most interesting and well deserving of attention, at a time when our thoughts must be directed to the advance of our troops in a country otherwise so little known to us.

8. GEOLOGY AND PALÆONTOLOGY.

(Including the Proceedings of the Geological Society.)

The second volume of the geological portion of the results of the Novara expedition has just been published. It contains essays of more or less interest on widely separated portions of the globe, some containing much new and important matter, while others chiefly confirm the observations of former explorers. In the latter category we must place the opening essay "On the Geology of Gibraltar," for although it contains much additional information on the Pliocene beds of St. Roque, and a copious list of its fossils (chiefly Foraminifera), the general facts of the case were known previously; and the same may be said of the Jurassic limestone forming the Rock of Gibraltar, and the caves with their bone-breccia. In the next memoir, "On the Gneiss of Rio de Janeiro," Dr. Hochstetter distinguishes two varieties of that rock, and a surface-formation—the result of its decomposition—analogous to the Laterite of India. The essay "On the Geology of the Cape of Good Hope," which follows next, contains a clear and concise description of the facts, but Dr. Hochstetter's interpretation of them does not differ materially from Mr. Bain's. The description of the peculiar surface-configuration of the country will be read with interest now that so large a share of the attention of geologists is occupied by such phenomena.

The geological description of the Island St. Paul, in the Indian Ocean, is remarkably interesting. This island is of volcanic origin; it has a form roughly resembling one-half of a pentagon which has been bisected by a line drawn from the apex to the centre of the base, and out of the middle of which has been scooped a semicircular portion which shows the position and extent of one-half of the crater. We thus have a volcanic atoll of a peculiar

shape, with this remarkable feature in addition, that the opening, which in coral islands is almost invariably on the windward side, is here on the leeward. Taking all these facts into account, Dr. Hochstetter arrives at the conclusion that one-half of the island is still beneath the sea, having been detached from the upheaved portion by a great dislocation. As soundings prove the existence of a considerable submarine plateau in the required position, which, if upheaved, would complete the pentagon, it seems tolerably clear that this explanation is the correct one.

An interesting description of the geology of the Nicobar Islands follows, Dr. Hochstetter assigning their Tertiary deposits to the same period as those of Java (the Upper Miocene), with which he believes them to have been more or less connected; later formations, consisting of coral-banks raised to a greater or less height above the sea, connect that period with the present. An excellent memoir on Java is closely connected with the last; it contains descriptions of the chief physical features of the island, and especially of its wonderful volcanoes. The stratified deposits are classified under the heads Eocene and Miocene. To the former belong a lower coal-bearing group and an upper nummulite-limestone; to the latter are referred a lower fossiliferous group, and an upper tufaceous group, with younger coral-banks, which may be of even more recent date. A description of the Stewart Atoll in the Pacific Ocean ends the geological part of this volume, and then follow two palæontological memoirs, one "On the Fossil Corals of Java," by Dr. Reuss, and the other "On the Fossil Foraminifera of Car Nicobar," by Dr. Schwager.

Dr. Hermann von Meyer has published an important memoir "On Mastodon" in the 'Palæontographica' for last year, and a summary of it in the 'Neues Jahrbuch' for December. He accepts Dr. Falconer's subdivision of the genus, but at present discusses only two of the subgenera, namely, *Trilophodon* and *Tetralophodon*. Each of these he still further subdivides into two groups, one having the valleys open, and the other having them closed by the adjoining hill. In *Trilophodon*, *Mastodon Ohioticus*, *M. Turicensis*, and *M. virgatidens* (Meyer) belong to the former group; and *M. angustidens*, *M. Pentelici*, *M. Humboldti*, and *M. Pandionis* to the latter. In *Tetralophodon Mastodon latidens* has the valleys open, and *M. Arvernensis*, *M. longirostris*, *M. Andium*, and *M. Perimensis* have them closed. The subgenus *Pentalophodon* he does not discuss.

We may here mention that the late Dr. Falconer's collected Memoirs have been published, edited by Dr. Murchison, in two very thick octavo volumes. Of these, the first contains a reprint of the 'Fauna Antiqua Sivalensis,' the plates also being in octavo, and interleaved with the descriptions; and the second volume contains

his miscellaneous papers, including those on *Mastodon* and *Elephas*. Unfortunately, these volumes are a mere fragment, many of Dr. Falconer's determinations and discoveries, though current amongst geologists, having never been published in detail by their author.

Among the reports on the Progress of Literature and Science in France is an important one by M. Daubrée on Experimental Geology, in which the author records the success which has attended those who have endeavoured to solve geological problems by imitating nature.

M. Renevier has published, in the ninth volume of the 'Bulletin de la Société Vaudoise des Sciences Naturelles,' the conclusion of his essay on the Cheville fauna. He comes to the conclusion that the Cheville beds contain three divisions, the upper being equivalent to our Lower Chalk, the middle to the "Upper Gault" of the Alps and Jura, corresponding, in the author's opinion, to our Upper Greensand, and the lower to the Middle and Lower Gault of Switzerland, or the Gault proper of English geologists. It is satisfactory to find that M. Renevier's elaborate investigation has led him to endorse our English classification, and to state his conviction that the "zone of *Pecten asper*," or "Lower Cenomanian" of French geologists, the Upper Greensand of England, and the Upper Gault of Switzerland, are but three *facies* of the same formation, having a position intermediate between the Gault proper and the Lower Chalk.

Professor Karl F. Peters has published an interesting memoir in the twenty-seventh volume of the 'Denkschriften' of the Vienna Academy, entitled "Grundlinien zur Geographie und Geologie der Dobrudscha." This district, which includes the lower basin of the Danube, is in many respects very remarkable. It contains representatives of the Bojic and Hercynian Gneiss, the Trias, the Lias, the Middle and Upper Jura, and the Cretaceous formation, with Miocene freshwater deposits, Steppe-limestone, and Loess. All these are described by the author, as well as many fossils from the Muschelkalk and the Middle Jura.

"Aus dem Orient. Geologische Beobachtungen am Nil, auf der Sinai-Halbinsel und in Syrien," by Dr. O. Fraas, is a very important book on a region but too little known to geologists. The author describes the crystalline rocks of the Sinai district and between the Red Sea and the Nile; the Cretaceous rocks of Palestine; the Eocene and Miocene formations of Egypt; the younger marine deposits, and the fluviatile formations of the Nile. There are many tempting subjects in this book, had we but space to recount them; amongst them we must mention the author's theory of ancient glaciers on Mount Sinai; the peculiar features of the "Wadis," and his theory of their formation; the description of the works on the Suez Canal, &c. There is one palæontological fact of great interest

and importance, namely, the discovery of three species of Nummulite in the Cretaceous rocks of Palestine; one of these is a variety of a species known to occur in the Eocene rocks of Europe, and cited also from Asia Minor and Kurdistan; one is an American species, said to occur in the Cretaceous beds of that continent; and the third, occurring in the Hippurite-limestone of Wadi Jös, is a new species.

Two works of great importance in Alpine geology have appeared within the last few months; but they are so extensive that no adequate idea of their contents can be given in this Chronicle. The larger work, by M. Favre, is entitled 'Recherches géologiques dans les parties de la Savoie voisines du Mont Blanc.' It consists of three octavo volumes of text, and a folio atlas of 32 plates, and is an exhaustive geological account of the Mont Blanc district. The smaller work plays the same part for the Swiss Jura, though not so completely. Its title is 'Essai géologique sur le Jura Suisse,' by Dr. J. B. Greppin.

The 'Geological Magazine' for the past three months has contained many articles of interest, including the continuation and conclusion of Mr. Belt's memoir "On the Lingula-flags," which the author treats as Upper Cambrian, and which he divides into six stages. Dr. Sterry Hunt has replied to Mr. David Forbes's criticisms on his Lecture at the Royal Institution, and the latter author has printed a rejoinder to the former's reply. One fortunate circumstance in this controversy is that students of chemical geology may, by reading these articles, become acquainted with many facts which they might otherwise lose sight of. Mr. Carruthers has a useful article "On British Graptolites," with an analytic key to the genera, which will be of great service to those endeavouring to master the subject. Mr. Maw has very cleverly found—or, rather Mr. Kippist has—a closer parallel to the much-discussed flower-like forms considered by Heer to be referable to *Porana*, and the first-named palæontologist has published his conclusions in a note, entitled "On a flower-like Form from the Leaf-bed of the Lower Bagshot Beds, Studland Bay, Dorsetshire." Finally, Mr. Ruskin has given another of his papers "On Brecciated Concretions."

Proceedings of the Royal Geological Society.

The Supplement-number to the volume of the Society's Journal for last year contains but two papers, both of great length and of considerable importance to British geology. The first paper is by Mr. Charles Moore, "On Abnormal Conditions of Secondary Deposits when connected with the Somersetshire and South Wales Coal Basins; and on the Age of the Sutton and Southerndown

Series." The author considers that the Mendip Hills were upheaved during the period of the Upper Trias by the intrusion of the basaltic dyke which runs along the ridge, and that they formed an island-barrier to the sea on its southern flank, where shore-deposits were formed during the succeeding periods; the Carboniferous Limestone forming then the bed of the ocean. Hence arose the accumulations of Liassic date which the author has found in veins in the Carboniferous Limestone of the neighbourhood, and from which he has obtained a most remarkable series of fossils comparable in many respects with those of the Halstatt beds. The Rhætic and Liassic beds within and those without the Somersetshire coal-basin present a striking contrast in their development; for while the latter attain a thickness of 3,320 feet, the former reach only to 169 feet. In one of the veins (the Charterhouse lead-mine) Mr. Moore discovered a *Helix*, a *Vertigo*, and a *Proserpina*, being the first traces of land-shells hitherto discovered in strata intermediate in age between the Tertiary and the Carboniferous periods. Mr. Moore also discusses the age of the Sutton Stone with considerable ability, coming to the conclusion that it is truly Liassic, and he seems to place it on the horizon of the *Ammonites-Bucklandi* beds of other localities. Many other questions are discussed in this valuable paper, which is rich in detailed sections, lists of fossils, and descriptions of new species, many of them being extremely remarkable.

The remaining paper is by Mr. Etheridge, "On the Physical Structure of North Devon, and on the Palæontological Value of the Devonian Fossils." It is so very elaborate, that we cannot possibly give an abstract of it. The chief aim of the paper is to show that (in opposition to Mr. Jukes's view) in West Somerset and North Devon the Devonian rocks form a regular unbroken ascending succession from north to south; that there is no fault of sufficient magnitude to invert the order of succession, or to cause the repetition of any considerable portion of the rocks. The paper is partly geological and partly palæontological, the former portion consisting of descriptions of sections, and deductions drawn from a consideration of them; the latter of tables of fossils illustrating the subject from every point of view, analyses of these tables, and conclusions drawn therefrom. The author proves—if lists of fossils can prove it—that the marine Devonian series constitutes an important and definite system distinct from the Carboniferous. We must refer our readers to the paper itself for further information, merely remarking that the tables of fossils are a perfect marvel of method and industry.

Only three papers in the February number of the 'Quarterly Journal' demand our attention. The first, by Dr. Duncan, brings to a conclusion that author's researches on the Fossil Corals of the

West Indies. In those islands Cretaceous, Eocene, and Miocene forms occur (the two former exclusively in Jamaica); but while the Cretaceous corals are singularly like those known from the lower chalk of Gosau, &c., and the Eocene present close affinities with the species of the London Clay and the Paris Basin, the Miocene fauna is very extensive, and its affinities are extremely diverse, but leaning especially to the existing Coral-fauna of the Pacific Ocean. Dr. Duncan shows also that recent extensions of our knowledge of the Miocene fossil corals lend strength to the hypothesis he had previously put forth with respect to the former existence of a belt of scattered islands across the Atlantic.

Mr. Medlicott's paper "On the Alps and the Himalayas" contains a comparison of the two ranges, chiefly in reference to their relations with the flanking Tertiary deposits. The clays, sands, and conglomerates of the Sivaliks resemble the equivalent portions of the Molasse, and are arranged in a similar order, the coarser deposits prevailing towards the top. In the Himalayas, as in the Alps, the younger Tertiary deposits dip *towards* the mountain-range which they fringe, and the plane of contact dips in the same direction, thus producing actual, though not parallel, superposition of the *older* rocks. In the Alps this abnormality has been explained by reference to prodigious faulting, and the same explanation, if true in one case, the author thinks should hold good in the other; but he brings forward evidence to show that in the Himalayas the present contact of the Sivalik formation with the mountains is the original one, modified only by pressure without relative vertical displacement. This pressure the author considers was produced by the sinking of the mountain-mass, which caused at the same time those contortions in the fringing Tertiary deposits which have hitherto been so difficult of explanation in the case of the Alps. He therefore submits that his explanation is the true one for both regions.

The last paper we shall notice is one by Mr. W. R. Swan, "On the Geology of the Princes Islands in the Sea of Marmora." The author describes most of these islands as consisting in great part of Devonian strata, differing somewhat in age from those of the Bosphorus, which belong to the Lower division of the formation. He therefore refers most of the stratified deposits to a Middle Devonian series, while others appear to him to belong to the Upper division. The rocks which form the remaining portions of the islands are—(1) Trachytic, of younger age than the Devonian strata, and (2) Trappean, more recent than the Trachytic. The quartz-rocks, of which some of the islands are largely, and others entirely composed, are altered sandstones of Devonian age.

The Council of the Society have awarded the Wollaston Gold Medal to Professor Carl Friedrich Naumann, of Leipsig, in recogni-

nition of his labours extending over nearly half-a-century in the departments of Geology, Mineralogy, and Crystallography; and especially for the admirable series of Geological Surveys of Saxony and adjoining countries, executed by himself and his coadjutors between the years 1836 and 1843; and for the great standard work on Geology (Lehrbuch der Geognosie), which, with the excellent courses of lectures delivered by him at Freiberg and Leipsig, has exercised a powerful influence on the education of the newer generation of continental geologists.

The balance of the proceeds of the Wollaston Donation-fund they have awarded to Mons. J. Bosquet, of Maestricht, in aid of the valuable researches on the Tertiary and Cretaceous Mollusca, Entomostraca, and other fossils of Holland and Belgium, on which he has been so long and successfully engaged.

We cannot conclude this Chronicle without bearing testimony to the great loss recently sustained by Natural Science in the death of Professor G. C. B. Daubeny, who was equally eminent as a geologist, a chemist, and a botanist, and who was also favourably known as a contributor to this Journal.

9. METALLURGY AND MINING.

Metallurgy.

Professor P. Tunner, of Vienna, has written very favourably * of a modification of the blast-furnace introduced by Mr. Fr. Lürmann, manager to the Georg-Marien Mining and Iron Company at Osnabrück, Prussia. From the recommendation of so eminent an authority as Professor Tunner, and from the fact that in many of the more important ironworks in Germany M. Lürmann's principle has been adopted, we feel compelled to notice it.

In this invention, the walls of the hearth are carried to the bottom on all sides, so that there is no opening in the front—no tymp and no dam. In the blast-furnace, as usually constructed, there is an opening in front—the short fore-hearth—about four feet long and three feet wide, which is closed in front by a wall called the dam. In Lürmann's furnace the scoria is discharged through a scoria-outlet about six inches below the twyers, which is dovetailed into a cast-iron plate fastened in the wall, and provided with canals for the circulation of cold water.

The professed advantages of the invention are said to be as follows:—

The slag discharges itself through the scoria-outlet, at about

* "Oesterreichische Zeitschrift für Berg und Hüttenwesen," 9th Dec., 1867.

the same level, and thus vacillations of the slag in the hearth are prevented.

As there is no fore-hearth, there are no repairs of it, equal to a saving of at least twenty days in each year; and as there are no interruptions, the furnace does not cool.

The doing away with the dam and the fore-hearth allows of the removal of the tamping-hole from the former into the wall of the hearth, by which its opening is rendered easy, it being close to the greatest heat. It is stated that the pressure of the blast can be increased without risk; that the number of charges can be greater, and a larger produce ensured. Beyond this, that the number of hands may be lessened, as the operations are few and easy. The smelters who, at Georg-Marien Hütte, when working with the old arrangement, were almost stripped, are now always in full working-dress.

We are not aware that any experiments have as yet been made with Mr. Lürmann's arrangement in this country.

A Mr. Plimsoll, who is, we are informed, a coal-dealer, and, if we mistake not, an unsuccessful aspirant after parliamentary honours, has published four letters "On Iron Manufacture" in 'The Times.' Mr. Plimsoll has visited some of the blast-furnaces of this country and many of those on the Continent, and he comes to the conclusion that the ironmasters of France and Belgium are far in advance of ours. It fortunately happens that Mr. Plimsoll, in his letters, furnishes sufficient examples of his own want of knowledge of the subject about which he has presumed to write, to carry conviction to all who are acquainted with it, of the total unfitness of such a man to offer an opinion on any branch of iron manufacture.

Mr. Plimsoll's letters have received a reply in the 'Pall Mall Gazette' from Mr. J. Lowthian Bell, the ironmaster of the Clarence Works, Cleveland, which fully and satisfactorily shows how little reliance can be placed upon any of the statements made by the 'Times' writer.

An economical application which we have lately seen requires some notice. It does not strictly come under the head of metallurgy; but as it results in the production of intense heat at low cost, we know of no more fitting section of the Chronicles for it. At the works of Messrs. Miller and Company, of Glasgow, the "dead oils" from the gas works—which are a waste material for which the gas manufacturer is glad to get a penny a gallon—are burnt under two steam boilers with great advantage and economy. In the morning the fire is lighted with coke or coal, and the fire-bricks heated. Then the *dead oil*, which flows down a long-necked funnel, is forced, by a small jet of steam, into the furnace. It ignites at once, producing an intense heat, which is maintained all day with-

out the addition of any other fuel. We were informed that some experiments were about to be made with those *dead oils* in the locomotives for the coal trains of the Caledonian Railway.

It is well known that lead, with a specific gravity of 11·5, will float on molten iron, the specific gravity of which is 7. There has ever been some difficulty in explaining this phenomenon. Professor Karmarsch, of Hanover, has lately, with the assistance of an ironmaster, been examining the subject. It appears that the moment the lead melts it forms a spheroid, which is hollow, and hence specifically lighter than the iron. The Professor supposes the formation of some vapour of lead, which becomes enclosed in the shell formed. Is it not probable that this is only another condition of the well-known spheroidal state of matter? Certain ores of iron contain sometimes considerable quantities of lead. When these are smelted, it is not unusual to find the lead "sweated out" at the *bottom* of the pig of iron, where we should expect to find it, according to its specific gravity.

A paper was read before the Liverpool Polytechnic Society, at the end of the year, "On the Manufacture of Steel from Cast-iron" by the use of nitrates and other oxidizing salts, by Mr. J. Hargreaves. The object of the invention is to effect the acieration of cast-iron by a direct process, and thus dispense with the many permutations which it is at present made to undergo before the condition of steel is attained. This is effected by the agency of oxidizing salts and oxides of iron and manganese. The oxidizing salts which are most suitable for the purpose are the nitrates, and especially the nitrate of soda, on account of its low cost, higher percentage of oxygen, and the highly electro-positive character of its base, which renders it a most effective agent in removing the metalloids—silicium, sulphur, and phosphorus—and the semi-metal arsenic from iron, by forming with them compounds of sodium, thus enabling inferior qualities of cast-iron to be used in the manufacture of steel, and also to improve the qualities of malleable iron by depriving it of those objectionable substances.

The above seems to be but a modification of Headon's process, which process was mentioned in a former number of the Journal.

There have been several patents taken out of late for improvements in the casting of Bessemer steel. Mr. James Astbury, of Smethwick Foundry, has patented a scheme for preventing the irregular cooling and chilling of the metal when poured into the iron moulds from the Bessemer ladle, which often produce cavities, of a honeycombed appearance, in the middle of the casting. For this purpose the moulds are made of plumbago, and previous to casting they are heated in a furnace sufficiently to prevent the metal from solidifying, and then when full are gradually cooled from the lower part, and as contraction takes place, the fluid metal

from the upper part descends, thereby preventing the formation of cavities in the casting.

Messrs. Waddington and Longbottom, of Barrow-in-Furness, have introduced improvements in the *moulds* for casting Bessemer steel, by dividing them into two parts horizontally, so that when the lower part becomes worn away by the splashing of the metal, it may be replaced by another, the upper part serving for several lower ones. The two parts are fastened together by bolts, which pass through lugs on the outside of the mould.

Mining.

Technical education is at the present time so much the subject of discussion, that it is of interest to receive the Report of the Miners' Association of Cornwall and Devonshire. This Association has for nearly ten years carried out, amongst the miners of Western England, a system of instruction in such branches of science as appear to be directly applicable to Mining and Metallurgy. One feature is peculiarly its own: instead of establishing a school in some centre to which those who desire instruction may come, a system of classes in the very midst of a group of mines has been adopted. The teacher visits these classes in regular order, and delivers his lectures, gives his demonstrations, and carries out his examinations. From the report we learn that many young miners who have availed themselves of the instruction given in the classes have secured positions of responsibility both at home and abroad, which they could not have taken but for their advanced knowledge.

Out of twenty-nine persons who passed the Government examinations in 1867 in Mineralogy, as many as twenty received their instructions from the lecturer of this Association, and of these fourteen have passed sufficiently high to be entitled to a prize. One of them, Francis Oats, a working miner in Botallack Mine, succeeded in obtaining the Gold Medal in Mineralogy from the Department of Science and Art. A plan of employing the more advanced pupils to teach the elementary branches in the schools has been carried out, with apparent advantage to all concerned, and by this arrangement the lecturer is enabled to cover more ground.

In the report before us, the papers read at the annual meeting of the Association are printed. They are peculiarly fitted to the requirements of the miner. There are eight papers on different descriptions of Rock-boring Machines, which are illustrated; two on Hydraulic Machinery applied to mines, fully illustrated, and several other papers of local and general interest on mines and mining.

Altogether, the experiment which has been carried on, with very limited means, by the Miners' Association of Cornwall and Devonshire is most encouraging. The report shows especially that

a system of well devised and properly applied technical instruction has the merit of eliminating from amongst the intelligent working men the best of the class, who are fitted by the instruction they receive to become the agents to whom will be committed in future the development of the British and Colonial mines.

We have been speaking of Boring Machines—a word on Coal-cutting Machines. The Lancashire Coal Association offered some time since three prizes of 500*l*., 200*l*., and 100*l*. for coal-cutting machines worked with compressed air. The conditions attached to the offer appear to have prevented inventors from entering their machines for competition. Three machines only have been entered at the present time. These are by Mr. Fidler, of Wigan; Mr. Sturgeon, of Leeds, and Messrs. Farrar & Booth, of Barnsley. We shall watch with interest the reports of the trials, and duly inform our readers thereof.

In the Eastern hemisphere the discovery of coal progresses, although much of it is far more recent than the true old coal of these islands. At Formosa, coal is found in depressions of the Red Sandstone; it burns freely, giving out much heat, and leaving fifty per cent. of ash. The coal of Labuan, Borneo, has been long known, but Dr. Cuthbert Collingwood calls attention to it in a paper read before the Geological Society. Several seams crop out conspicuously near the coast, the lowest seam being 11 feet 4 inches in thickness. The quality of this coal is thus given:—"It is heavy, close-grained, fast-burning, giving out considerable heat." This is also a recent coal—Damara resin and leaves of recent date being found associated with it. The coal of Japan is described as a bright, clean coal, resembling that obtained in the neighbourhood of Sydney. All these and several other small deposits of coal in the East are destined ere long to become of importance.

So important do the coal beds of India appear to our Government, that the India Board has just appointed Mr. Mark Fryar, who was formerly the teacher in the Mining School of Glasgow, as a surveyor, under Dr. Oldham. His duties are to carefully examine the conditions and the extent of the coal deposits, and to inspect the workings, with an especial view to their improvement and extension.

Mr. Bauerman, formerly of the Geological Survey of the United Kingdom, with Dr. C. Le Neve Foster, who has been for the last two years teacher to the Miners' Association of Cornwall and Devon, have started for Egypt. Those gentlemen are engaged by the Viceroy to make a mineral survey of several districts which are reported as producing minerals of commercial value.

Dœring's Rock-boring machine has been at work for several weeks in one of the levels of Tincroft mine, near Camborne, in Cornwall. The agent, Captain Teague, has expressed himself most favourably as to the results obtained by this machine; and so

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favourably does the engineer, Mr. Matthew Loam, think of it, that he is about to introduce this boring machine into West Seton, a neighbouring mine, of which Mr. Loam is the engineer.

It will be in the memory of our readers that some interesting and important experiments have been carried out in some of the collieries of Durham, and in the gas works at Barnsley, on safety-lamps. It had been found that, with improved ventilation, many of the lamps called safe were not so, owing to the rapidity with which the current of air, mixed with carburetted hydrogen, was driven through the wire gauze. The result of the experiments, most of which have been reported in the 'Transactions of the Institute of Mining Engineers,' has been to prove that, with but slight modifications, several forms of the safety-lamp can be rendered actual lamps of safety.

10. MINERALOGY.

Even in a science that makes such tardy advance as Mineralogy, it is highly desirable that its literature should from time to time be collected, classified, and epitomized, so that the student may possess periodical records of its progress, arranged in a form convenient for reference. In 1843 Von Haidinger of Vienna undertook this task, and prepared a report on mineralogical progress during that year. Haidinger's example was followed by Dr. Kenngott, who issued similar works, reviewing the science from the year 1844 to the close of 1861. At length, however, the perseverance even of a German gave way, and since 1861 nothing of the kind has appeared. The much-felt want of a continuation of Kenngott's "Forschungen" induced the Imperial Academy of Sciences of Vienna to offer a prize of 1,000 Austrian florins, placed at its disposal by the Archduke Stephen, for a record of mineralogical research, extending from the beginning of 1862 to the close of 1865. We now learn from the German journals that the labour of collecting and arranging this four years' literature has been accomplished, and that the prize has been awarded to some diligent compiler whose work bears the motto, "*Nunquam otiosus.*" On the publication of this work, the mineralogist may congratulate himself upon having a complete series of reference-books, extending over nearly a quarter of a century. Let us hope that the good work of continuing this record may never again be allowed to lapse.

Under the name of *Woodwardite*, Professor Church some time ago described a new mineral, which occurs as a beautiful blue incrustation coating a Cornish killas or clay-slate. M. Pisani, the French chemist, has lately examined this mineral, and does not scruple to demolish the species at once. Woodwardite, says M. Pisani, so

far from being entitled to a specific distinction, is simply a mixture of the basic sulphate of copper called Langite, with a hydrous alumina such as Gibbsite. By way of confirming this assertion, he points to another Cornish mineral, which in its general characters —colour excepted—bears a close resemblance to Woodwardite, but which on analysis proved to be a mixture of Langite with Allophane or some such silicate of alumina. It would seem then that this Langite has the sociable habit of mingling itself with other minerals, thus giving rise to a number of indefinite mixtures, which, however deceptive in appearance, must by no means be regarded as distinct species.*

For the last twelve years large quantities of *Cryolite* have been worked in Greenland, partly for use in the manufacture of aluminium, and partly for the production of a pure soda-ash; but although extensively employed in commerce, the mineral has never been found in a crystallized form. Recently, however, small crystals have been discovered, and some of these specimens we have had an opportunity of examining. They are coated with a thin film of hydrous peroxide of iron, but on the removal of this incrustation the vitreous lustre and transparency of the crystals are at once evident. At a cursory glance they appear related to the cubic system, but on careful measurement Dr. Websky finds that they must be referred to the doubly-oblique system.† It is pleasing to note that this determination verifies a conjecture thrown out some years ago by Descloiseaux, who was led to his conclusion by studying the optical characters of the massive mineral.

In a recent memoir Dr. Dana discusses at length the chemical composition of the felspars, in order to explain the close relation which exists between the different members of this natural group—a relation extending not only to crystalline form and chemical composition, but also to the colour, hardness, optical characters, and other physical properties of the minerals. Among these felspars the species *leucite* occupies an anomalous position; for, although clearly related to the family in most of its features, it yet crystallizes in cubic instead of oblique forms. To reconcile this anomaly Dana ingeniously shows that the cubic and oblique crystals are in truth intimately connected; that "the monoclinic crystals of orthoclase and the triclinic of anorthite, &c., are in fact nothing but distorted, or, rather, *clinohedrized dodecahedrons*, variously modified by cubic, octohedral, trapezohedral, and other planes."‡

Every right-minded student cherishes so profound a respect for

* "Sur la Woodwardite du Cornouailles," 'Comptes Rendus,' lxv., No. 27, p. 1142.

† "Ueber die Krystallform des Kryolith's." 'Leonhard's Jahrbuch,' 1867. Heft, vii., p. 810.

‡ "Crystallogenic and Crystallographic Contributions:" 'Siliman's Journal,' vol. xliv., No. 132, p. 398.

the name of Dana that we are loth to notice an alleged charge of plagiarism recently brought against him in connection with his views on the relation between crystalline form and chemical composition.* Professor Hinrichs, of Iowa, alleges that some of the ideas expressed in the papers on this subject had their source in a memoir of his own recently written on "Atom Mechanics." It is needless to say that Dr. Dana refutes this charge triumphantly, and shows it to be utterly groundless. By the way, the "Atom Mechanics" just noticed contains some curious arguments which will at least amuse the reader if they fail to convince him. The professor believes in the chemical unity of matter, and recognizes the existence of only one true element, one all-pervading form of primitive matter, or *Urstoff*, which forms the basis of everything material, and which he introduces to us under the name of *Pantogen*. The "Atom Mechanics" may, however, be commended to the reader, if only for its curiosities of style and elegance of illustration. For example, wishing to express the impossibility of basing a mineralogical classification upon crystalline form, the professor tells us that "One might quite as well classify asses according to the lengths of their caudal appendages expressed in centimetres, as minerals by their systems of crystallization!"

Availing himself of some specimens of ruby, or red corundum, exhibited in the Colonial Department of the Paris Exhibition, M. Jannettaz has studied the nature of the colouring matter of this gem. He found that on exposure to heat the red colour rapidly gave place to a bright green, but that on cooling, the mineral resumed its original tint. Previous experiments on the spinel-ruby had shown that this gem when heated exhibits precisely the same behaviour.†

Analyses of between 30 and 40 different coals from various localities in Prussia, together with a comparison of their respective calorific powers, have been published by M. Mène,‡ who obtained his specimens from the Paris Exhibition. The analyst throws his results into a tabular form, and, trusting to their intrinsic value, leaves them without comment.

In the clefts of some of the Lower Silurian sandstones of Bohemia, a couple of new minerals have lately been discovered, and described by Von Zepharovich.§ Both of these are hydrous phosphates of alumina, closely related to the well-known species Wavellite. One of them is to be called *Barrandite*, in compliment to the zealous geologist of Bohemia, Joachim Barrande; and the

* See 'Quart. Journ. of Science,' Jan. 1868, p. 103.

† "Observations minéralogiques sur quelques minéraux de l'Inde, et en particulier sur la nature de leur coloration." Bull. de la Soc. Géol. de France. XXIV. No. 5, p. 682.

‡ 'Comptes Rendus,' LXV. No. 20, p. 807.

§ Sitzungsb. d. k. Akad. Wiss. Bd. LVI., p. 19.

other *Sphærite*, in allusion, we presume, to the nodular forms in which it occurs.

Some peculiar blowpipe re-actions have been detected by Captain W. A. Ross, R.A.* Having fused a borax bead in the usual way, he charges it with the substance under examination, and then blows the bead into a small bubble or vesicle of extreme thinness. After standing for some hours, this vesicle exhibits under the microscope a peculiar crystalline structure, often of great beauty, and as this structure apparently varies with the nature of the dissolved substance, it promises to become of value in blowpipe analysis. "Every metal, with its salts, appears like a kind of mineralogical kaleidoscope throwing its crystallizations apparently at random into the most elegant shapes, each of which must be made to yield its atom of information as to the source of all."

Professor G. Rose has also studied some curious phenomena exhibited by certain blowpipe beads. He finds that the opacity which they frequently assume on cooling, results from the separation of microscopic crystals. His researches on the reactions of titanic acid appear to have some bearing on the natural formation of anatase.†

The Russian chemist Hermann proposes the name of *Rewdanskite* for a new nickel-ore from Rewdansk in the Urals. It occurs as an earthy greenish mineral, consisting of hydrous silicate of nickel, in which much of the nickel-oxide is replaced by magnesia and protoxide of iron.‡

In the deposits of sulphate of lime largely worked in Hants Co., Nova Scotia, no fewer than three new borates have been discovered within the last few years,—thanks to the zeal of the local professor, Dr. How. These minerals have been described under the names of *cryptomorphite*, *natroborocalcite*, and *silicoborocalcite*. The chemical relations, as well as the differences between these three species, may be best seen by placing their formulæ side by side.§

Cryptomorphite..... $NaO2BO^3,6HO + 3\,(CaO2BO_3,HO) + BO^3,3HO$.
Natroborocalcite ..... $NaO2BO^3,10HO + 2\,CaOBO_3,HO) + BO^3,3HO$.
Silicoborocalcite ..... $2CaOSiO^2 + 2\,(CaO2BO_3,HO) + BO^3,3HO$.

Splendid samples of brown pyromorphite, or phosphate of lead, from the mines of Nassau, have lately been met with in commerce. Dr. Fuchs has analyzed some of this "Braunbleierz," and finds it to be a remarkably pure chloro-phosphate, exactly agreeing in composition with the formula already established. The same chemist has examined the Swedish mineral *Tabergite*. ‖

In a paper "On the Constitution of the Aluminous Augites and Hornblendes," Professor Rammelsberg discusses the chemical com-

* 'Chemical News,' Dec. 20, 1867; and Feb. 7, 21, and 28, 1868.
† 'Akad. z. Berlin,' 1867, p. 129.
‡ 'Journ. f. prakt. Chemie,' Bd. cxx., p. 405.
§ 'Phil. Mag.' Jan. 1868, p. 32. ‖ 'Leonhard's Jahrb.' 1867, Heft vii., p. 822.

position of an important class of minerals; and in another paper offers some remarks "On the Scheelite of the Reisengebirge" in Silesia, a new locality, which yields this rare mineral in crystals of surpassing beauty.*

Professor vom Rath's "Mineralogical Contributions" to 'Poggendorff' relate to the antimonio-sulphide of lead, called Meneghinite, from the silver-lead mine of Bottino in Tuscany; and to some new and rare forms of calcareous spar.†

The zeolitic mineral called *Lerderite*, found in the trap rocks of Nova Scotia, has been shown by Professor Marsh to be identical in composition with Gmelinite.‡ Mr. E. W. Roots announces a new locality for the Canadian mineral, *Wilsonite*;§ and Von Hanthken describes the occurrence of *Meerschaum* in the Lyubicer mountains, in Bosnia, where it is found in large fragments associated with serpentine, embedded in a conglomerate.‖

11. PHYSICS.

LIGHT AND HEAT.—The action of light on chloride of silver has been studied by M. Morren. He arranged an experiment in the following way. Two bulbs, one containing nitrate of silver, the other, chloride of potassium, in equal equivalents, were placed in a tube sealed at one end. The tube was then filled with water saturated with chlorine gas, and sealed before the blowpipe. By agitation, the bulbs were broken, and chloride of silver was thus formed in an excess of chlorine water. Exposed to the rays of the sun for several days, the chloride of silver remained white as long as the liquid retained the yellow colour given to it by the chlorine. When the colour disappeared, owing to the action of chlorine on the water, under the influence of light, the chloride of silver slowly assumed a red-brown tint. The tube being then placed in obscurity (or in the diffused light of the laboratory), the brown colour gradually disappeared, and the chloride of silver reassumed, in all its intensity, its original white aspect. Replaced in the sun's rays, the coloration returned, disappearing as before when screened from the light.

Mr. J. Browning, F.R.A.S., has published a paper in the 'Chemical News,' "On the Influence of Aperture in Diminishing the Intensity of the Colour of Stars." Mr. Browning, during the late lunar eclipse, had failed to detect either the coppery or the

* 'Zeitsch. d. Deutsch. Geol. Gesell.' Bd. xix., Heft 3, pp. 493, 496.
† 'Pogg. Ann.,' 1867, No. 11, p. 372.
‡ 'Silliman's Journal,' 1867, No. 132, p. 362. § Ibid., Jan. 1868, p. 47.
‖ Verhand. d. geol. Reichsanst, 1867, No. 10, p. 227.

blue tints generally seen during the occurrence of this phenomenon, while other observers had noticed these tints distinctly. The paper alluded to is an explanation of the discrepancy. Mr. A. Brothers had previously, at a meeting of the Manchester Literary and Philosophical Society, read a paper, in the course of which he compared the statements of different observers. He had himself distinctly seen colour, with a refractor of five inches aperture. The moon's surface presented, owing to the presence of this colour, an appearance of great beauty, which seemed to increase as the penumbral shadow stole over it. The colour of the eclipsed limb was of a coppery hue, much brighter towards the part most deeply within the shadow. The part of the moon not eclipsed was of a beautiful bluish-grey colour. Mr. Browning's evidence, published in the 'Astronomical Register,' was—"I looked most carefully for colour, both with the 10½-inch silvered-glass reflector, furnished with an achromatic eye-piece of very low power, and also with a five-feet refractor; with neither could I detect a trace." Mr. Slack observing in the same locality, with a silvered-glass reflector, writes in the 'Intellectual Observer'—"After twelve the eclipsed limb grew noticeably redder, the red coppery tint chiefly affected the lower parts of the obscured limb, but was visible further in, gradually blending with the inky tints presented by the umbra at its advancing edge." Lastly, Mr. Weston, who was observing at Lansdown, near Bath, saw colour. He recorded the following in the 'Monthly Notices':—"The prevailing colours were red-bluish and grey, *and grey:* the redness increased towards the darkened edge of the moon." Mr. Brothers thinks that the appearance of colour cannot be caused by the telescope or by peculiarities in the eyes of the observers, proved by the fact that the same colours are seen, whether refractors or reflectors, either of metal or silvered glass, be used; and as the majority of observers of the phenomenon see colour, he thinks the eyes of those who remark its absence are perhaps afflicted with colour blindness.

Mr. Browning, in the paper first alluded to, says that his having used a telescope of larger diameter than that possessed by the telescopes employed by most of the other observers had been suggested as a probable explanation by Mr. Slack, as well as by Mr. Huggins. The result of inquiries he has instituted completely confirms the idea. He finds that while most observers who used telescopes of only three or four inches aperture speak of the colour as being less than usual yet very noticeable, observers who used telescopes of seven or eight inches aperture saw very little colour. Three other observers using telescopes with large apertures failed to detect any colour. Experimenting in connection with this subject, he has noticed that the chocolate colour of the so-called

belts of *Jupiter* is much more perceptible with 6-inch apertures than with apertures of 12 inches: also a small star in the cluster in *Perseus* appears of an indigo-blue with $8\frac{1}{2}$ inches, Prussian-blue with $10\frac{1}{4}$ inches, and royal-blue with $12\frac{1}{4}$ inches of aperture. From this it follows that colours estimated by comparison with Admiral Smyth's chromatic scale, in which each colour is represented of four degrees of intensity, can possess no relative value unless taken with the same aperture.

The spectroscope has received from Professor Osborn, of Lafayette College, U.S., improvements which have rendered it applicable to a variety of practical purposes, particularly in metallurgy. By means of the instrument thus modified it is possible to detect in a room many hundreds of yards from a furnace, the sodium in the coal, or decomposed fire-brick, also any lime, potash, &c., proceeding from the furnace-mouth. Professor Osborn is hopeful of important uses being found for the form of spectroscope he has devised.

Dr. Emerson Reynolds, at a meeting of the Dublin Chemical and Philosophical Club, read a paper "On the Action of Ozone on Sensitive Photographic Plates." He had found in experimenting upon this subject that the latent or undeveloped image submitted to the action of ozone was completely obliterated: a second image might be taken on the plate. Dr. Reynolds remarked that this fact was at variance with what might be called the mechanical theory of photographic images, and proved conclusively that the production of an image was due to a chemical change in the sensitive film. He thought that the disputes with regard to the time dry plates might remain sensitive, arose in some degree from the variable amounts of ozone present in the atmosphere. The ozone used in the experiments was in some cases obtained by passing atmospheric air over phosphorus, in others by the aid of electricity.

A new photometer has been devised by Mr. C. H. Bennington, M.A., and described by him in the 'Philosophical Magazine.'

In a paper "On Phosphorescent Light," Dr. Kindt mentions that a piece of chlorophane, which heated in a tube gives a green light visible in daylight, viewed through a spectrum apparatus in the dark shows homogeneous green only. Phosphorite of Estremadura shows green, yellow, and red. A green fluorspar, from the Breisgau, shows two dark lines in the green, one of which is near the orange red. The dark lines are as powerful as in solutions of didymium. Two other bright green fluorspars give rise to the same bands.

Mr. William Huggins, F.R.S., has described to the Royal

Society a Hand Spectrum-Telescope devised by him in the summer of 1866, for the purpose of observing the spectra of meteors and their trains. The apparatus consists essentially of a direct-vision prism placed in front of a small achromatic telescope.

A paper "On the Action of Sunlight on Glass" has been published by Mr. Thomas Gaffield in 'Silliman's American Journal.' Mr. Gaffield found the greatest change in the colour of glass to take place in the summer, the least in winter, and that in spring and autumn about equal, and midway between these extremes. Crystal or lead glass and a piece of optical glass, containing probably little, if any, manganese, suffered no change by two years' exposure. Coloured glasses after two or three years' exposure showed no perceptible change in any instance, excepting a slight one in a single purple specimen. Experiments made with artificial heat of various degrees of intensity showed the colour of glass to be unacted upon by heat; the same or similar specimens, almost without exception, undergoing change by a few months' exposure to sunlight. Specimens exposed in hot water for a month indoors and out of sunlight experienced no change in tint; similar ones exposed during the same length of time in a dish with two or three inches of water out of doors, suffered a decided change, though only about half as much as when exposed directly, without the aqueous medium. Mr. Gaffield arrives at the conclusion that air moisture and artificial heat effect no change in the colour; the change appears to be due to the actinic rays of the sun alone.

Heat.—Dr. J. P. Joule, F.R.S., has described a thermometer unaffected by radiation. It consists of a copper tube about one foot long, having another tube open at both ends in the centre, and the annular space filled with water. In the inner tube there is a spiral of fine wire, suspended by a filament of silk, and having a mirror attached to it. The lower end of the tube is closed by a lid, capable of removal at pleasure, and when this lid is removed, if the air in the tube have a different temperature from that of the outside atmosphere, a current of air and a consequent turning of the spiral will be the result. In Dr. Joule's apparatus, one degree Fahrenheit produces an entire twist of the filament. He finds the temperature in the tube to be generally warmer than in the outside atmosphere of a room, owing to the conversion of light and other radiations into heat on coming in contact with the copper tube. This result is also manifested in the open air on a still day; when there is wind the effect is masked. Dr. Joule feels confident that this difficulty may be overcome by increasing the length of the tube.

In a memoir on Dissociation, by M. Debray, presented to the Academy of Sciences, he has stated that a hydrated salt has for each

temperature a tension of dissociation which is measured by the elastic force of the aqueous vapour which it emits at this temperature. Applying this to the explanation of the phenomena of hydration and efflorescence, he states further that a salt becomes hydrated when the tension of the aqueous vapour contained in the atmosphere is greater than that which the salt emits at the same temperature. Efflorescence results when the tension of the water-vapour of the salt is greater than that of the aqueous vapour existing in the atmosphere. Hydrous salts which do not effloresce owe, then, this property to the inferior tension of aqueous vapour emitted by them at common temperatures to that ordinarily possessed by the aqueous vapour in the atmosphere. These identical salts effloresce when placed in an atmosphere where the elastic force of the aqueous vapour contained in the air is below that which they emit.

Professor Knoblauch has made an investigation on the interference-colours of radiant heat. Some of his results are embodied in the following:—When two groups of rays meet under certain conditions, radiant heat differs in its properties after the meeting; for instance, as regards its property of traversing diathermanous bodies, it manifests an interference-colour. If this is produced in doubly refracting crystals, under the influence of a polarizing agent, placed for instance between two Nicol's prisms, and the plate of crystal fixed while one prism is rotated, the colour passes through white to the complementary. On rotating the plate of crystal in its plane, when the principal sections of the Nicol's prisms are parallel, only one thermal colour occurs; when they are at right angles, the complementary colour; while when they form an angle of 45°, both thermal colours appear.

Experiments have been made in Germany which tend to show that molten lead dropped upon liquid iron remains floating on the surface of the latter. Since the specific gravity of lead is more than one-half greater than that of cast-iron, the fact seemed anomalous. Professor Karmarsch, of Hanover, has explained the matter very satisfactorily. Some samples of these drops of lead lying embedded in the surface of a cast-iron block were sent to the Professor by an ironmaster. Professor Karmarsch found, upon close examination, that these drops of lead were not solid globules, but hollow, formed apparently as bubbles. According to this explanation, the lead is kept resting on the surface of the iron by its own vapour. In large quantities the result is known to be different, lead being occasionally tapped from the bottom of blast furnaces employed in smelting certain classes of ores.

The value of petroleum as fuel for steamship boilers has been for a considerable time under investigation by the United States

Naval Department. The Secretary has finally reported against petroleum; the only advantage thus far shown is a not very important reduction in bulk and weight of fuel carried.

ELECTRICITY.—H. Poggendorff has published an account of a new electrical phenomenon observed by him. This physicist was experimenting with exhausted tubes containing a certain quantity of mercury, having either at one end or both, platinum wires, when he encountered the phenomenon. More precisely the circumstances under which his first observation was made were the following:— A tube of the kind described above, containing only one wire, coated towards both extremities with a broad band of tinfoil, was placed as an exhausted double jar across the electrodes of a Holtz's machine. While the tube lay in this position on the electrodes, there appeared to be a certain motion in the mercury. As this motion could have no definite character, the current in such a jar being an alternating one, another tube was made provided with platinum wires at both ends, and the current passed through the length of the tube, the tube being placed as far as possible horizontally. In this case a more decided motion of the mercury was observed, but still scarcely as decisive as could be desired. A third, fourth, and fifth tube showed the phenomenon in about the same degree. A sixth tube, however, removed all doubt. This had not only been carefully exhausted, but the mercury in it had been kept briskly boiling for some time; the mercury was kept out of contact with the platinum wires by the tube being bent at right angles at about an inch from each end. The tube thus prepared was hung by wire hooks to the electrodes of the machine, in such a manner that the body of it was perfectly horizontal, the mercury serving as a level. As soon as the adjustment was properly made, the machine was set in action. When the current passed through the tube, the mercury rapidly travelled from the negative to the positive pole. However the current was sent, the result was always the same. In experimenting, the mercury was generally made to occupy a thread of about 4 inches in length; the horizontal part of the tube was about a foot in length, so that the thread had to move over a space of 8 inches. Two or three seconds was the time generally occupied by the mercury in travelling from one end to the other. The thread changes shape as soon as it commences to move, becoming considerably longer; the elongation amounted in these experiments to an inch. The quantity of mercury set in motion was one ounce; very small quantities of the metal will not move, probably a result of adhesion.

H. Poggendorff also believes himself entitled to state generally that the electro-negative metals, platinum, gold, palladium, silver, &c., render the following insulators positive by friction, while the

electro-positive metals, zinc, cadmium, iron, &c., induce in these insulators the negative condition—ebonite, gutta-percha, caoutchouc, waxed cloth, white wax, resin, shellac, sealing-wax, sulphur, amber, copal, silk, pyroxyline, collodion, and gun-cotton. There are a few exceptions in the behaviour of the metals. A good example of the general law laid down is furnished by ebonite. Gently rubbed with platinum it becomes positive, zinc or iron inducing the negative condition.

M. H. de Saussure has published a paper in the 'Bibliothèque Universelle,' "On the Humming Sound produced on Mountains by Electricity." In June, 1865, M. de Saussure and a friend climbed the peak of Piz Surley. When the summit had been reached, sleet fell abundantly; preparatory to taking their repast, they laid the alpenstocks against a little cairn of dry stones. Almost at the same moment, M. de Saussure felt acute pain in one shoulder, speedily in the other also, and in the back. The pain resembled the pricking of pins. Soon the alpenstocks resting against the rock commenced to sing loudly, the sound resembling that emitted by a kettle of water about to boil. Strong currents of electricity flowed from all the salient parts of the body, and the hair stood out. M. de Saussure remarks that in every instance where the phenomenon has been observed, the mountain peak has been enveloped in a shower of frozen sleet.

A new voltaic battery has been devised by Dr. Hugo Müller and Dr. Warren De la Rue. The negative element is chloride of silver fused around a silver wire, which serves as conductor; this wire is bent over and connected by means of a small caoutchouc collar to a rod of zinc, which need not be amalgamated. The exciting liquid is salt water. In course of time the liquid becomes saturated with chloride of zinc; when metallic zinc begins to deposit on the negative plate the battery must be renewed with fresh solution. The tension of a battery of ten cells (the couples being very small, about three inches in height) is sufficiently great to decompose water enough to yield a cubic inch of the mixed gases in about twenty minutes. Dr. De la Rue has constructed a battery of two hundred cells.

M. Bourgoin continues his investigation regarding the electrolysis of organic acids. The current acts on acetate of potassium as on a mineral substance. In a moderately alkaline solution the oxygen reacts on the elements of the anhydrous acid, giving rise to carbonic acid and hydride of ethylen. A certain quantity of acid is totally consumed under the influence of oxygen furnished either by the salt or by the alkaline water. The portions of liquid at the two poles suffer unequal losses; almost the whole is lost at the

positive pole. When the current is made to act on free acetic acid it concentrates the acid at the positive pole. He has also examined the action of the current on neutral tartrate of potash, on a mixture of tartrate and alkali, also on free tartaric acid. With the neutral tartrate, as soon as the current passes, the solution becomes alkaline at the negative pole; the principal result is the formation of a white precipitate at the positive pole. Analysis has shown this substance to be cream of tartar. The gas evolved at the positive pole was found to be composed of carbonic acid, oxygen, carbonic oxide, and nitrogen. When the current acts on a mixture of neutral tartrate and alkali the results are different. The gas evolved at the positive pole is then composed of carbonic acid, carbonic oxide, oxygen, and hydride of ethylen: acetylen has also been detected in it. The decomposition of free tartaric acid yielded the same products as the neutral tartrate, but in different proportions. Acetic acid was formed at the positive pole, and after an experiment had been in progress five days, a considerable quantity was isolated as acetate of baryta.

12. ZOOLOGY—ANIMAL MORPHOLOGY AND PHYSIOLOGY.

(*Proceedings of the Zoological Society of London.*)

Morphology.

The Size of the Brain in Different Races of Men.—Dr. J. Barnard Davis has communicated a paper on this subject to the Royal Society. There has always been considerable difficulty in getting at a knowledge of the variation of the brain in various races, because it has been thought necessary to examine and weigh the brain itself, and this has not been done in the case of many exotic races. The method of gauging the skull cavity has been said to be of no real value, and hence has not been extensively applied. Dr. Davis shows that this is a mistake, and possibly the method of gauging is more reliable than that of weighing, for thereby the error likely to arise from the shrinking of the brain during fatal disease and from post-mortem changes is avoided. Dry Calais sand is used for gauging the brain-case, and an allowance of 15 per cent. is deducted for other structures present in addition to the brain. This amount has been very carefully estimated from a large series of observations. The sand is then weighed and reduced to its equivalent in cerebral matter of 1,040 specific gravity. Professors Tiedemann and Morton, who have made similar observations to those of Dr. Davis, omitted to make this allowance, and also (a much more important omission) did not discriminate male and female skulls. This led to serious error, since the female brain is

on the average 10 per cent. less in weight than the male. As the result of his investigations Dr. Davis gives a long list which is very interesting. He gives as an average 47½ oz. for the English brain, 45½ oz. for the French; Italians, Lapps, Swedes, and Dutch nearly the same as English. As to the Germans, he has not got a satisfactory result. Hindoos have 44⅛ oz. of brain, the aboriginal Khonds of India only 37⅛ oz., whilst Chinese and Siamese have 47 oz. Of African races, the more northern negroes have from 44 to 46 oz. of brain, whilst in the south we find the greatest contrast of capacity known, for whilst the Bushmen range from 31 to 39 oz. only, the Kafir has on an average over 48 oz., a greater weight of brain than has the average Englishman. The bold and enterprising Malays present a high brain-weight (over 47 oz.), as also do the supposed aboriginal inhabitants of the Western Pacific. Dr. Davis does not state what collection of skulls it is which he has used in making these calculations. From some of his remarks, it is evident that the collection is not a very large one, and thus the value of the results is diminished. Several hundred cases ought to be collated in each race to give a satisfactory result.

Fur-seals and Hair-seals.—Dr. J. E. Gray has been recently writing on these animals, which are not only matters of curiosity to the world at large, on account of their strange forms, and of interest to zoologists especially, but also have a very considerable commercial importance in respect of their skins and their fat. The Eared-seals (*Otariadæ*) inhabit the colder parts of the southern hemisphere; they are also called "Fur-seals" by the sealers, because they have a soft under-fur between the roots of the longer and more rigid hairs. Some are called "Hair-seals" because they have only rigid hairs, and are not worth making into "seal-skins." These are only hunted for their fat, the skins if used being only applied to common purposes, such as covering boxes, &c., as with the skins of the ordinary Earless-seals. Though zoologists have had great difficulty about distinguishing the various species of Eared-seals, it is not so with the practical dealer in skins; he knows the difference between the various kinds of skin at a glance, just as the dealers in whalebone were in advance of scientific men in distinguishing the species of whale by their baleen. With regard to the Sea-bear which was lately exhibited in the Zoological Gardens in London, Dr. Gray decides that it is the *Otaria jubata*. There has been great difference of opinion on this point, but Dr. Gray has examined the skull of the animal. He is anxious to see the account of the anatomy of this specimen, which Dr. Murie is to publish. The French sailor, Leconte, who brought this Sea-bear to England from Cape Horn, has been sent by the Zoological Society to the Falkland Islands, for the purpose of procuring some other seals of the southern hemisphere.

The Sea-horse and its Young.—We in England have lately had the opportunity and pleasure of seeing those extraordinary little fish the *Hippocampi* alive, and supported by their strange prehensile tails clasping rocks or corals, in the aquaria of the Zoological Gardens in London. In the 'American Naturalist,' we read an account of the habits and young of the American Sea-horse, written by the Rev. Samuel Lockwood. He had long wished to ascertain in what condition the young first appeared, and had repeatedly failed, owing to the death of the males which he obtained. In these fish, and also in the Pipe-fish and Pegasus, the female lays her eggs into a cavity of considerable size, which is placed along the tail of the male, and there the eggs remain until they are hatched, when the father squeezes them out of his pocket. Mr. Lockwood believes that the walls of this pocket in some way or other furnish nourishment to the ova, since they increase so largely while within it. After many failures he obtained a Hippocampus which did not prematurely turn out his young, but squeezed them out duly—active, transparent little creatures—to the number of several hundreds. Immediately on coming into the water the young fish began to use its prehensile tail, and curious mishaps were noticed—two or three often intertwining their little hair-like caudal appendages, and pulling in opposite directions. Mr. Lockwood did not succeed in rearing his young troop of Sea-horses, nor did he examine them with the microscope, which he should have done.

A Fish living inside a Gigantic Sea-Anemone.—Whilst searching about for animals on the shores of the China Sea, Dr. Cuthbert Collingwood saw an enormous blue sea-anemone, two feet in diameter, and a little fish swimming near it. On raking out the inside of the anemone with a stick, six other little fishes swam out of it, and these he caught with a hand-net. Several times he saw these anemones and their fish, but unfortunately the specimens of the fish he brought were destroyed. In the 'Voyage of the Astrolobe,' a fish is mentioned as living inside a *Holothuria*, and several of these were seen by Dr. Collingwood about Labuan. But the fish which goes inside the sea-anemone is distinct from this species. Mr. Low, of Labuan, kept one alive for some months in a tub without the anemone, which seems to show that its habit of taking shelter within the capacious stomach of that benevolent creature is not a necessity of its existence. Fishes which inhabit the body cavities of large medusæ are well known even on our own coasts. The writer saw such a medusa and fish recently in the Channel Islands.

The Silkworm Delusion.—In an interesting new magazine, by name 'The Student,' Mr. Shirley Hibberd gives an account of an attempt at silk cultivation in Britain. He describes how an estate of a thousand acres was bought, and carefully planted with the

Ailantus glandulosus, the tree on which the *Bombyx cynthia* worm feeds. This species is the only one with which there is any chance in Great Britain, and accordingly it was the one chosen for cultivation. After the trees had grown up, the eggs were obtained and hatched, and the process of feeding and growing went on finely. At length the cocoons were obtained; and now came the question, What is the value of the cocoons when you have got them? To this the answer is indeed very disappointing. They are the least in value of any silkworm's cocoon, and are in fact almost rubbish. They do not give a continuous thread of one or two thousand yards, as does the *Bombyx mori;* no, nor even of one or two yards: like cotton, they have to be carded. And this being done, it was found after a year or two that the estate yielded about ten shillings per acre; by great good fortune, the next year it yielded eight, while potato-fields yielded twenty pounds; and then, much to the relief of the unhappy silkworm-cultivator, a good sharp frost killed off his *Ailanti* and *Bombyces*, one and all, in the same night. Silkworms are all very well as toys or entomological specimens, but in Britain they are commercially a failure.

Polymorphism among Corals.—The name "polymorphism" among animals has been applied to the phenomenon which consists in the co-existence of two, three, or more forms of a species, each serving some appropriate function for the benefit of the species collectively. In males and females, we have the ordinary case of "dimorphism;" in the males, females, and neuters of bees we have a case of polymorphism, which might be designated trimorphism. Among the great ants of South America, Mr. H. W. Bates has described a case in which, besides males and females, there are three forms of workers. In the Cœlenterata, polymorphism is well known by striking examples among the Hydrozoa,—the various individual polyps which make up a polypary having often different forms in different regions, and fulfilling various functions—*e.g.*, mouths, swimming bells, grasping appendages, and reproductive bodies, attached or becoming separated, as free jelly fish; all acting as members of one household. Professor Kölliker has lately made the discovery of true polymorphism among various genera of Anthozoa also. This polymorphism consists in the existence, besides the large individuals capable of taking nourishment and furnished with generative organs, of other smaller, asexual individuals, which appear essentially to preside over the introduction of sea-water into the organisms, and then over its expulsion, and which are, perhaps, at the same time, the seat of an excrementitial secretion. Like the others, these asexual individuals possess a body-cavity divided into chambers by eight septa, and a pyriform stomach with two orifices. On the other hand, they are entirely destitute of tentacles; and instead of the eight ordinary

mesenteric filaments, there are only two, supported upon two consecutive septa. The cavity of the body of these individuals is always in communication with that of the sexual individuals; but the mode in which it is effected varies in the genera. Among the coral forms which exhibit this interesting polymorphism are the sea-pens, *Virgularia* and *Pennatula*. With the exception of *Sarcophyton*, Professor Kölliker has not observed this dimorphism in any of the Alcyonidæ or Gorgonidæ.

Do Molluscs bore by Acids?—There are some naturalists, devoted conchologists, who lose their temper whenever this question is asked, considering that it has been completely settled that acids have nothing to do with the holes made in limestones by *any* animals whatever, because a *Pholas* has been found to have bored into a piece of gneiss. Ten years ago M. Troschel, an eminent observer, detected a considerable quantity of free *sulphuric acid* in the saliva of a Gasteropod — *Dolium galea*. MM. de Luca and Panceri have lately resumed the investigation of this subject, and have found between three and three-and-a-half per cent. of free sulphuric anhydride in the saliva of this animal; they did not find any hydrochloric acid. They have detected sulphuric acid also in four species of *Tritonium*, in a *Cassis*, a *Cassidaria*, two *Murices*, and an *Aplysia*. The part played by these acids and the carbonic acid which they also obtained in large quantities is still obscure; but there can be no doubt whatever that were one of these molluscs to eject its fluid on a piece of carbonate of lime (either the shell of its prey or the rock on which it lives), that carbonate of lime would be dissolved, destroyed, and eroded. The detection of an acid, and the ascertaining of its chemical nature, is interesting in connection with the discovery by Mr. Ray Lankester of an acid excretion from the body of a species of *Leucodore*, and of *Sabella* which bore cavities in limestone rocks.

The Nature of Monads.—It appears from the researches of the last five years, that many forms of minute life, which at one time were regarded as forming families or groups by themselves, are really the common modification or stage of existence through which many and widely differing organisms pass. At the same time it appears probable that this common stage of existence is represented in a few cases by adult forms. The cases to which we allude are, firstly, *Monas forms;* secondly, *Amœba forms;* and thirdly, *Acineta forms*. There is little doubt that Amœba is an adult and distinct form, as also is Acineta; at the same time, Cienkowski has shown that certain minute vegeto-animal organisms pass through first a Monas stage, then become small actively creeping Amœbæ, and finally, becoming encysted in cellulose and tinted with chlorophyll, break up into spores, which again become Monas forms; whilst De Barry has described a Monad and Amœba stage in the *Myxomy-*

cetes. Stein and others have shown that a large number of Infusoria, when first they emerge from the parent Infusor—by the breaking-up of whose nucleus or ovary they have been formed—assume the Acineta form, exhibiting those peculiar sucker-like pseudopodia which are characteristic of the remarkable *Acineta.* Now it is freely admitted that there are *Amœbæ* and *Acinetæ* which are not mere transient stages of an existence; but is it so with *Monas?* Professor H. James Clark, of Philadelphia, has recently done much to solve this question. He has used very high powers of the microscope, and has studied the Monas forms of ponds and streams. He describes and figures, in a very careful and satisfactory manner, a mouth, nucleus, and contractile vesicle in what he calls the *Monas termo* of Ehrenberg; and he describes, in addition, a series of forms exhibiting two, six, or more monads, united by stalks, and lying within cup-like sheaths. These forms he maintains lead ultimately to the ciliated Sponges. Just as we may regard the ordinary "sponge particles" as Amœbæ, and the sponge therefore as an aggregation of Amœbæ with a horny and siliceous skeleton, so in the case of *Leucosilenia* and others, Professor James Clark thinks we must consider the sponge-particle as a flagellate Monad—a more or less complete gradation leading from the simple Monas, through the compound forms with their cups and stalks, up to the ciliated Sponge.

A New Group of Protozoa.—Professor Cienkowski has discovered a new organism, which like some others of simplest structure, holds a doubtful place between plants and animals. These creatures, to which he gives the name *Labyrinthulea,* were found encrusting the weed-grown posts in the harbour of Odessa. They are of microscopic dimensions and form a network of thin, reticulate, colourless filaments, on which fusiform bodies circulate very slowly in various directions. In various parts are embedded globular masses, from and into which the filaments appear to arise and to be inserted. The reticular arrangement is sometimes supplanted by an arborescent form. The network as well as the arborescent ramifications spring from a central mass, which is sometimes as big as a pin's-head. The substance of the filaments is solid and non-contractile, hence they are not like the pseudopodia of Rhizopods. The fusiform corpuscles are nucleated and nucleolated, and appear to consist of a protoplasmic substance. The cause of their movement is very obscure. The relation of these organisms to other groups of Protozoa or Protophyta is very difficult to pronounce upon, since they seem to present but very little definite relationship with any one more than another. The corpuscles multiply by division, and occasionally the whole Labyrinthula becomes encysted, but there is nothing known of the reproductive process which will help to determine their affinities. They must be considered as a new group of Protozoa.

New Manual of Physiology.—A new text-book of Physiology, in two thick octavo volumes, has been written by Mr. John Marshall, F.R.S., Professor of Surgery in University College, London. The merit of the book lies chiefly in this, that a certain amount of Comparative Anatomy is introduced, together with the Human Anatomy and Physiology. A really good and original work on general physiology for the use of students is sadly wanted. It is reported that Dr. Michael Foster, of University College, is preparing a treatise on Development (in the whole animal kingdom), which is just the book that is wanted. There is *nothing* at present in English on the development of the lower animals.

Hunterian Lectures.—Professor Huxley is giving his lectures as Hunterian Professor this year on the Invertebrata. The lectures are very largely attended, and are of great interest. Professor Huxley does not believe that a sharp line can be drawn between plants and animals, but would regard man and the magnolia-tree as extreme terms of one long series, diverging on the one hand to the vegetable, on the other to the animal kingdom. In the first lecture the various groups of the Protozoa were discussed, and the general classification of Invertebrata. Two series were pointed out leading upwards from the Protozoa—one passing through infusoria, worms, and annelids to the articulate animals, the other through the sponges, corals, and polyps to the Mollusca. The gradation which thus existed was, Professor Huxley considered, an undeniable fact; it was another question as to whether that gradation indicated genetic relationship, and one which could not yet be discussed.

Zoological Society of London.

At the commencement of the present session in November, Dr. Sclater, the secretary of the Society, read an account of several recent additions in the Society's menagerie; amongst these were a penguin (*Spheniscus demersus*), from South Africa, two great ant-eaters (*Myrmecophaga jubata*), one from Brazil, presented by Dr. A. Palin, and the other from New Granada, presented by Mr. P. Brandon, and a young walrus (*Trichecus rosmarus*). The walrus has since then died, and investigations of its anatomy and of the cause of death have been carried on by Dr. Murie, the prosector. Dr. Murie reports that the animal's death resulted from ulceration of the stomach, due to the presence of very numerous entozoa, which were new, and named by Dr. Baird *Ascaris bicolor*.

Amongst communications made to the Society relative to the mammalia are the following:—Mr. W. H. Flower, "On the Osteology of the Sperm Whale," in which he showed that there was no sufficient evidence of the existence of more than one species of sperm whale, for which he was of opinion that Linnæus's name, *Physeter macrocephalus*, ought to be retained; Dr. Blyth, "On Asiatic Species

of Deer;" Dr. J. E. Gray, "On the Cats (*Felidæ*) in the British Museum," and "On the Pigs (*Suidæ*) in the British Museum;" Captain Dow, on a young living specimen of the new Tapir, from Central America (*Tapirus Bairdii*), which he has obtained for the Society's menagerie, and is shortly about to forward to Europe. Dr. Sclater drew the attention of the Society to the fact that the Eland was becoming recognized as a meat-giving animal, specimens having been exhibited by Lord Hill at the late Smithfield Club Cattle Show, which he believed were the first that had appeared in the European markets. Mr. Gerard Krefft, who is curator of the Australian Museum at Sydney, has discovered, amongst the very fine collections of fossil bones in that institution, a specimen of the humerus of a gigantic fossil *Echidna;* of this he sent a notice to the Society, not giving the new fossil species a name, since he was not sure if the species were known in Europe or not.

With regard to Birds, besides very many papers describing new species from various exotic localities, we have to record a note by Dr. Peters, of Berlin, "On the Homology of the Quadrate Bone in the Class Aves," in which he controverts the view recently maintained by Professor Huxley as to its supposed correspondence with the *incus* in the mammalia. Dr. Hector announced to the Society the discovery of an egg of the Great Moa (*Dinornis gigantea*), containing an embryo, found in the province of Otago, New Zealand, at a depth of about two feet below the surface. Professor Owen has also communicated two memoirs on the same great birds, being the eleventh and twelfth of his series of papers on this subject. These papers contained descriptions of the integument of the sole of the foot and of the tendons of a toe of *Dinornis robustus*, and a description of some bones of *D. maximus*. Professor Alfred Newton, of Cambridge, exhibited to the Society the humerus of a large species of extinct Pelican, which he has discovered in the Cambridgeshire fens. Several other new birds, reptiles, amphibia, and fishes have been described to the Society. The work done in Invertebrata has also been of considerable importance. Dr. Baird, of the British Museum, has laid before the Society a monograph of the group *Gephyrea*, those very strange worms which in external appearance seem to connect the Annelids with the Echinoderms, but are really true worms. Dr. Bowerbank read a paper "On the European Glass-rope"—the *Hyalonema Lusitanicum* of Bocage—which he maintained from examination of its minute structure was not even specifically distinct from the Japanese species, although Dr. Gray had placed the Lusitanian form in a new genus. Dr. Gray, at the following meeting, maintained that he was right, in spite of what Dr. Bowerbank alleged. According to Professor Max Schultze, however, both these gentlemen hold erroneous views as to the coral or sponge nature of *Hyalonema*.

THE PUBLIC HEALTH.

Since our last report the Registrar-General has published his yearly summary of the weekly returns of Births and Deaths, and causes of death in London during the year 1867. The whole is contained in a pamphlet of twenty-seven pages, which mainly consists of tables summarizing the information contained in the weekly returns issued from Somerset House. From these dry figures, however, much useful information may be extracted for the use of those who are interested in the Public Health. Nor are we quite confined to the consideration of the Metropolis in the present annual survey. A new feature has been recently added to the weekly returns in the form of a return of the weekly mortality of thirteen of the largest cities and towns of the United Kingdom. The result of these returns is also given in the present summary, and we are thus enabled to compare the mortality of London with other towns in the kingdom. It would be, however, wrong in any estimate of sanitary conditions and requirements to regard London as one city. The Metropolis, in fact, is a congeries of cities and towns, which have become agglomerated by the growth of each. London and Westminster were once separated by a district as free from houses as London is now separate from Harrow, but the interspace has grown up, and thus Hampstead and Islington, Hackney, Bow, Greenwich, Woolwich, Dulwich, Clapham, Wandsworth, Kensington, and Paddington form now but parts of the great Metropolis, which takes its name from the central city, whose sleeping population does not at present exceed 115,000 persons. Nevertheless, the occupations, wealth, soil, elevation of these several united towns and cities vary so much as to render a close scrutiny necessary, in order to ascertain what are the physical and social conditions that are influencing the health of the Metropolis.

In 1867 the population of the Metropolis was estimated to be 3,082,372. The ascertained population in 1861 was 2.803,989. This vast aggregate of human beings live in a district of 122 square miles, which is intersected by the river Thames. On the north side of the river lie 51 square miles, and this is occupied by three-fourths of the population; on the south side there are 71 square miles, with the remaining fourth of the population. This vast mass of people live in 340,917 houses, in which must be enumerated 46 workhouses, 12 prisons, 4 military and naval asylums, 31 civil hospitals, 8 military and naval hospitals, and 19 lunatic asylums. The Metropolis is, in fact, a kingdom in itself,

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representing and repeating the whole empire. In this population of above three millions there died in 1867, 70,588 persons; during the same period there were born 112,264: thus giving to London an increase in her population by birth alone 41,676 persons. It is, however, to the death that we must turn our attention. The death of London in the last year contrasts favourably with that of the four preceding years. The proportion of deaths to 1,000 living persons being a little less than *twenty-three.*

In 1862 it was twenty-three-and-a-half in the thousand, in 1863 it was twenty-four-and-a-half, in 1864 it was twenty-six-and-a-half, in 1865 it was twenty-four-and-a-half, and in 1866 it was twenty-six-and-a-half. In 1864 the large mortality was produced by the cold of that year, and in 1866 by cholera. The mortality of the present year, like all years succeeding visitations of great epidemics, has undoubtedly been reduced by the weaker members of the population having fallen victims to the epidemic cholera of the previous year, but also and chiefly to greater sanitary activity. In order to estimate the saving of life between 1867 and 1864 or 1866, we must multiply each thousand of the population by three, which gives us 9,000. Some estimate may be formed of the saving to the community thus occasioned, when we recollect that not only has much valuable and wealth-producing life been saved, but that the expense of funerals and the loss of time and expense occasioned by at least 120,000 illnesses—calculating that where one person dies from an unsanitary cause, twenty are attacked with illness and get well—have been avoided.

The death-rate of London contrasts favourably with the death-rate of the twelve large towns quoted in the Registrar-General's weekly reports.

Thus for the year 1867 we find the following death-rates:—

1.	Manchester	31·40 in the 1,000 living.
2.	Newcastle-on-Tyne ..	30·79 „
3.	Liverpool	29·57 „
4.	Glasgow	28·54 „
5.	Salford	28·50 „
6.	Edinburgh	27·13 „
7.	Dublin	27·06 „
8.	Leeds	26·96 „
9.	Hull	24·93 „
10.	Sheffield	24·67 „
11.	Birmingham	24·27 „
12.	Bristol	23·08 „
13.	London	22·98 „

At the end of 1866, London did not stand so well in the list, and this was clearly due to the outbreak of cholera. Great com-

parative credit must be given to London for this pre-eminence in health. In connection with this high sanitary position, it should be recollected that London has had now for above ten years a body of Medical Officers of Health, and none of the other towns on the list have had the advantage of such an officer for that period. We believe, however, with the exception of Manchester, that they all have a Medical Officer of Health. It is a significant fact, that Manchester in 1867 presents the highest mortality. We have, however, to announce that Manchester has at last appointed a Medical Officer of Health, and we hope soon to have to record the advantages conferred on the city by his agency. In order, however, that it may be seen what is the real difference between the mortality of London and Manchester as indicated in the above table, we would remind our readers that if the death-rate of Manchester had been in 1867 as low as that of London, that 3.258 *lives would have been saved!* Manchester has a school of politicians of its own, addicted according to some writers to a mercenary consideration of profit and loss. Will not some of their statisticians calculate for them the loss upon these three thousand two hundred and fifty-eight lives? Manchester has Christian Churches and Philanthropic Societies, and a Ladies' Sanitary Association. Cannot some of the ministers and secretaries of these associations cast up, for the benefit of Manchester people, the amount of agony that might have been saved, wretchedness and want and disease short of death that might have been prevented, had the causes that slew this mass of human beings been withdrawn in time?

It will be seen that Newcastle-upon-Tyne stands second on the list. The mortality of this town stands much higher than formerly, and its present high rate demands attention. It should be recollected in these towns that a few years ago a death-rate of 30 in the 1,000 was considered so exceptional, that the Government has power to interfere when the mortality of a town has continued above that rate more than a year.

Liverpool has gone through a fiery trial, and after long taking the lead as the most deadly city in the empire, may be congratulated in standing third on the list. It is to be hoped that even the present rate of mortality will be diminished before long. We need not comment further on this list except to point out the low mortality of Hull, Sheffield, Birmingham, and Bristol as compared with the other large towns of the United Kingdom. Hull more especially is to be commended: it lies low, below the sea-level (as the recent flood showed), and is surrounded by a swampy country. It should, however, be remembered that a death-rate of 24 in the 1,000 is unnecessarily high, and that where it exists at that point, it can most assuredly be reduced by sanitary measures to a lower figure.

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Although London presented the low rate of 23 in the 1,000, it must not be supposed that this is not subject to lower and higher rates in its various districts. As a rule we find that the closer and thicker the population, the greater the mortality. We are not able to say how this influences the relative mortality of Manchester and Birmingham, but it is remarkable in the registration divisions into which London is grouped. The Registrar-General recognizes five divisions:—1. The Central, which includes St. Giles, Strand, Holborn, Clerkenwell, St. Luke, East and West London, and the City: in this group the mortality was 24 in the 1,000. 2. The Eastern district comprises Shoreditch, Bethnal Green, Whitechapel, St. George's-in-the-East, Stepney, Mile End Old Town, and Poplar: the death-rate in this district was also 24 in 1,000. 3. The Northern division, including Marylebone, Hampstead with its Heath, Pancras, Islington, and Hackney, all with great unbuilt-on spaces; here the death-rate was only 23 in the 1,000. 4. The Western district, including Kensington, Chelsea, St. George's, Hanover Square, Westminster, St. Martin-in-the-Fields, and St. James, Westminster: in this group there is less free space, but it includes the wealth of London, and its mortality was 22 in the 1,000. 5. The Southern group; this includes all the south side of the water; it comprises the teeming populations of Lambeth, Southwark, Deptford, and Greenwich, but also the almost country districts of Wandsworth, Clapham, Dulwich, and Blackheath: here the death-rate is 21 in the 1,000. This last division has an area almost six times as great as the Eastern and Central divisions together, and a population not equal to these two divisions combined. It is a fact worthy of notice that the south side of the Thames from 1845 to 1864 has exhibited a higher rate of mortality than it does the present year. There is no doubt that this is due, first, to a supply of purer water, by the water companies having obtained supplies of purer water; and, secondly, that the new system of metropolitan drainage is beginning to tell favourably upon the health of the south side of London.

An interesting feature in the weekly bills of mortality of a large population is the fluctuation which it presents. Thus, taking the London returns, we find that the highest number of deaths registered in any week in the year 1867 was 1,891, occurring in the week ending the 12th of January. The lowest number of deaths in any week in the same year was in the week ending June 22nd, when only 1,052 deaths were registered. The study of these figures in connection with atmospheric vicissitudes, of which copious details are given in the Registrar-General's Reports, would appear to throw some light on the causation of disease; but, with the exception of temperature, we are not able to connect the fluctuation of the death-rate decidedly with any other meteoric condition. The

relation of temperature to the great death-rate of the second week in January, 1867, is very obvious. It not only occurred in London, but in all the other twelve populations. In London the death-rate went up from 27 in the 1,000 to 33, in Salford from 29 to 39, in Sheffield from 22 to 32, in Dublin from 25 to 31. Now during the first week in January the mean temperature at Greenwich was 25°, and the lowest temperature was 6°. It was in the second week this wave of cold told upon the communities of the United Kingdom, and although the temperature during the next three weeks was not so low, it was still low, and the populations all had high death-rates during the remainder of January. The first quarter of the year consequently presented a higher death-rate. The next highest death-rates we meet with are in the third quarter, and these manifestly arise from a high temperature. The mean temperatures of the first four weeks in August were above 60°, and we find during and after this increase of heat the death-rates increasing. Although sanitary arrangements can do nothing to prevent the fall and the rise of the thermometer, they can point out what ought to be done to mitigate the effects of cold and heat on the human body. Warm clothing and fires indoors are the great means of preventing the disastrous effects of cold in winter, whilst fresh air and pure water are needed to neutralize the effects of overcrowding and profuse perspiration in the summer.

Of the 69,000 deaths in London, 15,000, or nearly a fifth of the whole, were due to zymotic diseases. This is probably about the proportion that these diseases would bear to the whole death of each of the large populations whose death-rate has been given. Zymotic diseases are especially regarded as preventible diseases. They all depend on a contagious poison conveyed from one body to another, and it is quite possible by proper means to prevent their spreading. Amongst these diseases we mention first small-pox, because its very existence amongst us is a disgrace. We know how to prevent it, yet from ignorance, carelessness, and grosser oversight, 1,332 people died of this disgusting disease in London alone. We have no means of ascertaining the extent to which this disease prevailed in other populations of England in 1867; but in the Twenty-eighth Annual Report of the Registrar-General we find that in England and Wales alone there died of small-pox—

1862	1,628
1863	5,964
1864	7,684
1865	6,411
	21,687

These figures are truly alarming, and if the mere statement of facts in this way could produce any impression, it ought at once to

induce action of a much more efficient kind than the passing of the Vaccination Act of last year. We fear that no mere legislation will effect much for staying this plague. There must be a deep sense of responsibility with regard to the existence of this disease impressed upon the community, so that every parent and neighbour may recognize it as a duty to see that the only means of preventing its occurrence, early vaccination, is had recourse to.

Sir James Simpson, in a recent communication to one of the Medical Journals, proposes to "stamp out" small-pox in the same manner as the cattle plague has been stamped out. Of course he excepts the process of immediately killing the animal attacked. What he really means is this, if a case of small-pox is at once taken in hand, placed in strict quarantine, and only those allowed to approach the individual attacked who have already had the disease, or been vaccinated, and every article of clothing in contact with the diseased body destroyed, you may defy the extension of the disease. This is true of all other infectious diseases. If a child attacked with scarlet fever is at once placed in a room by itself, and only those allowed to enter who have had the disease, and every precaution taken to destroy poison in the excretions, and in the clothes worn and used by the patient, then the disease will not spread. It is a well-known fact that when a case of typhus fever is taken into a hospital, and every precaution taken to prevent the spread of the poison, it seldom or never spreads. It is the utterly careless and abandoned way in which these pestilential diseases are treated in the homes of the poor that causes their spread and the desolation that follows. When these diseases occur, whether it be in London or other towns, no serious efforts are made to "stamp them out;" a *laissez-faire* system is adopted, which at the end of the year is summed up in such forms as follow: "Whooping-cough carried off many children all over London; and diarrhœa, which was the most fatal of the Zymotic class, caused 2,294 deaths. Cholera, chiefly *cholera infantum*, was fatal in 241 cases; typhus and typhoid fever, &c., in 2,174 against 3,232, and 2,681 in the two previous years."

The London people have, no doubt, occasion to be thankful that those two last diseases had diminished in severity. But why should there be 2,000, or 200, or any typhus and typhoid at all? These fevers are bred of causes which are well known. Typhus is the offspring of overcrowding, and typhoid of bad drainage. In some districts of London, as Mayfair, in St. George's, Hanover Square, Eltham, and Lee not a single case occurred in the whole year. In Dulwich, the Golden Square district of St. James, Westminster, and St. Olave's, Southwark, only one fatal case occurred in the year. These instances taken at random from the Registrar-General's returns, show that these diseases may be kept at bay, and are kept at bay, and very diligent inquiries ought immediately to be set on foot,

where deaths from these diseases occur in large numbers. Paddington, Westminster, Marylebone, Pancras, Shoreditch, Hackney, Mile End, Whitechapel, on the north of the Thames, and Walworth, Lambeth, Battersea, and Camberwell, are the great seats of these diseases on the south side of the Thames. Of all forms of zymotic disease, typhus and typhoid are the most easily arrested, and the most worth arresting, and for the same cause. They chiefly attack and carry off the adult. The adult can more easily be taught the value of and danger to his own life, than the child who is at the mercy of others; whilst the sad fact that it is the fathers and mothers of families who are carried off by these diseases, ought to quicken the apprehension of all rate-payers as to the great economy in saving this valuable life to the community.

Of the remaining 55,000, some are not, but some are clearly under the control of sanitary agencies. Thus, for instance, there were 8,817 deaths from consumption. This is essentially a disease of underfeeding, overcrowding, and deficient muscular activity. It is found present in the cottages of the agricultural poor, where the wages are insufficient to support the rapid growth of girls and boys approaching adult years; it is found in the workshops of tailors and milliners, who are herded together in close rooms all day, and who sleep in overcrowded bedrooms at night; it is found especially amongst those who sit all day at their occupations, and have little or no leisure for bodily exercise. Returns for the Metropolis, of which no account is taken in the Registrar-General's summary, clearly show that where the population is dense and where the occupations are sedentary, there the deaths from consumption are at a maximum; and that where the population is less dense, and open-air occupations are the rule, the mortality from this disease is at a minimum. This shows the importance of securing a sufficient amount of healthy space for those who work at sedentary occupations, as well as the necessity of providing in all densely populated districts open spaces for their exercise and recreation.

Whilst on this subject, we would refer to an Act passed during the last Session of Parliament, entitled "An Act for regulating the Hours of Labour for Children, Young Persons, and Women employed in Workshops." This Act is supplementary of the Factory Extension Act, by which all establishments employing more than fifty persons in a manufacturing process are subject to the inspections and other requirements of the Factory Act. It is intended especially to apply to all shops where children, young persons, and women are employed. The following are the principal requirements of this Act:—

1. No child under the age of eight years shall be employed in any handicraft.

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2. No child shall be employed on any one day in any handicraft for a period of more than six-and-a-half hours, and such employment shall take place between the hours of six in the morning and eight at night.

3. No young person or woman shall be employed in any handicraft during any period of twenty-four hours for more than twelve hours, with intervening periods for taking meals and rest amounting in the whole to not less than one hour and a half, and such employment shall take place only between the hours of five in the morning and nine at night.

4. No child, young person, or woman shall be employed in any handicraft on Sunday or after two o'clock on Saturday afternoon, except in cases where not more than five persons are employed in the same establishment, and where such employment consists in making articles to be sold by retail on the premises, or in preparing articles of a like nature to those sold by retail on the premises.

All persons employing women or children in contravention of this Act are liable to fines set forth in the Act. All inspectors and officers of health suspecting the Act to be infringed can have power granted them to enter premises by the order of a justice. Further provisions are made in this Act for the education of children employed in factories.

This Act, like all other sanitary Acts, is only permissive. Should it please a vestry to shut its eyes to the evils of overworking children and women, they may allow the Act to remain a dead letter. There is, however, one vestry in London that has moved in this matter, and that of a parish which has perhaps more overworked women in it than any parish in London, and that is the parish of Saint James, Westminster. This parish which, in a population of 36,000, numbers 1,500 sempstresses, presents a legitimate field for the operation of this Act. The vestry have ordered that the Act be circulated through the parish, and that all complaints of the infringements of its regulations shall be registered at the vestry-hall for the purposes of inquiry, and prosecution if necessary. The same has been done in some country-towns in Scotland.

Leeds.—We have to submit to our readers this time a special report on the sanitary condition of Leeds. Coincident with the generally improved state of the public health, Leeds, as contrasted with the past, presents a favourable aspect. The mortality during the present year, up to March 7th, has been at the rate of 24 per 1,000 per annum, against 32, 36, and 29 in the corresponding periods of 1865–1867. The sanitary condition, however, can be more correctly gauged by reference to that truest of all tests, the comparative number of deaths from Zymotic diseases.

The following table shows the relative proportion of deaths from this class during the corresponding periods of 1866, 1867, and 1868:—

Deaths from principal Zymotics during corresponding Periods of 1866, 1867, *and* 1868.

From January 1st to March 7th.

	1866.	1867.	1868.
Small-pox	15	12	6
Measles	32	12	1
Scarlatina	41	19	22
Whooping Cough	44	42	26
Croup	33	17	18
Diarrhœa	33	6	21
Typhus, Typhia, and Typhinia ..	154	60	50
Dyphtheria	5	8	1
Total	357	176	145

Such results as the above are satisfactory and encouraging to those who are endeavouring to elevate the healthiness of the towns but unfortunately this improvement in the sanitary status produce, another effect, *viz.*, that of creating in the minds of town councillors a desire to rest and be satisfied, deducing, as such gentlemen are apt to do, the inference that a low death-rate affords a ready subterfuge against charges of inert policy. In Leeds there are hundreds of cesspools immediately under, or adjoining dwelling-houses, which the Town Council, in their Improvement Act of 1866, obtained powers to abolish; yet that body now hesitate to enforce the law, forsooth, because such a course would probably incur the risk of loss of seat in the coveted council chamber. After perusing the above, our readers will not be surprised to hear that the powers delegated to the local authority by the Sanitary Act of 1866 are but feebly executed, and that the members of the Corporation require awakening to the necessity of adopting vigorous prophylactic measures in order to combat—if not stamp out—preventible diseases, like typhus, typhia, small-pox, scarlatina, &c.

For want of a public abattoir in Leeds, there are upwards of a hundred private slaughter-houses, in the hands of private individuals, distributed in various parts of the town, where in many instances they are not only a source of prodigious nuisance, but afford also, in consequence of difficulty of supervision, facile opportunities for unprincipled butchers to slaughter and dress diseased animals. The large profits to be derived from such a trade are, as can easily be imagined, an immense temptation to engage in the traffic; and should the colour or consistence of the meat be such as to prevent the vendor from disposing of it in the shape of ordinary joints, it undergoes what is termed in the tech-

nical phraseology of the craft "boning"—to be then consigned to the meat-pie or sausage manufacturer.

One more instance will suffice to show how far town councillors can be entrusted to carry out existing laws, or the demands of modern science.

The Nuisances and Scavenging Committee themselves possess one of the most gigantic nuisances that can possibly be conceived—to wit, a depôt for town garbage, placed in one of the most densely populated neighbourhoods of the town, where this refuse in its passage through the various states of putrefaction is converted into a saleable manure for the farmers, who fetch it away at their convenience. Surely such facts prove how much the public mind in Leeds needs educating concerning the immense advantages which flow from obedience to sanitary laws; and moreover, such knowledge, when generally diffused, would produce the utterance of unmistakable language, and teach our local rulers, that in order to retain their seats on the aldermanic bench, they must—regardless of sordid interests—busy themselves in promoting the social well-being of the poor and ignorant in their wretched homes.

Scotland.—Since the last reference was made in this Journal to the subject of Public Health in Scotland, much has been done, both in the cities and large towns, and among the smaller communities, towards bringing about an improvement in their sanitary condition. Town Councils, Police Commissions, Parochial Boards, and other corporate authorities have been organizing measures for improving the Public Health, and lowering the very high death-rate which has too long prevailed. During the last few months the desire to put the "house in order" has been very manifest throughout the greater part of Scotland, especially in small communities where there were no police acts to empower the authorities to deal with sanitary matters. Now the provisions of the General Police and Improvement (Scotland) Act, 1862, commonly known as Provost Lindsay's Act, and Public Health (Scotland) Act, 1867, are at their disposal, and certainly it is a healthy sign to note the energy that is being displayed in many places to have those provisions put in force, especially in respect of such matters as the drainage and water-supply.

It may not be inappropriate to commence with sanitary affairs in Scotland as they present themselves to our notice in Glasgow.

One might naturally expect that in Glasgow there would be such an amount of energy and public spirit among her merchants, manufacturers, clergy, and others, that such measures as are known to be conducive to the maintenance of a high standard of Public Health would not only be taken by the public authorities, but that they would soon be put in operation through the assistance and for

the benefit of the people at large. A measure which, in the minds of some of its promoters, undoubtedly had this object in view, is the Improvement Act, which was passed by Parliament in the session of 1866. It may be remembered that this Act provides for the expenditure of 1,250,000*l*., in order that the unhealthy dens, wynds, courts, and lanes that have been allowed to grow up and accumulate in the lapse of centuries might be rooted out, and be supplanted by open squares and thoroughfares, and by dwelling-houses constructed according to the most approved plans for the sanitary well-being of the occupants; and that, in short, the denizens in the heart of the city should no longer be secluded from the healthy influences of the sun's rays and the pure air of heaven. The benefits expected to ensue from the operations of the Improvement Act are removed farther into the future than was wished by ardent sanitary reformers. So soon as the police assessment papers were issued for the first year under the Improvement Act, complaints both loud and general were raised against the Act, because it was found by the taxpayers that, to the already heavy load of taxation for general police and sanitary purposes, there was to be superadded no less than sixpence per pound on the rental for improvement purposes. That amount of assessment was the utmost limit allowed by the provisions of the Act. The people began to consider that they were to purchase the improvements at too great a cost, that they were "to pay too much for their whistle." What made the load seem still heavier, was that the occupiers were compelled to pay the whole of the assessments, while the owners of household property were allowed to go "scot free." The Lord Provost, who was the chief promoter of the improvement scheme, lost his place in the Town Council in consequence; and very soon thereafter the rate for improvement purposes was reduced to fourpence per pound for the second year. Considering the great depression and dulness prevailing during the last year or two in the engineering, shipbuilding, and other staple trades of Glasgow, the resolution come to by the Improvement Act Commissioners was certainly a wise one, as it is not desirable that the lawfully constituted local authorities should be guilty of such conduct as is prone to provoke opposition to their decisions from any large body of the ratepayers, many of whom have always ample demands made upon their hard earnings.

The position which Glasgow occupies in respect of water-supply is one that may well be envied by London and many other large communities. In a city of upwards of half-a-million of people the supply of water is 26,400,000 gallons daily, and of this quantity about six-sevenths is obtained from Loch Katrine by an aqueduct whose total length is thirty-four miles. The aqueduct could convey as much as 50,000,000 gallons per day; and this, be it noted, is water of great purity (2¼ grains of soluble matter per gallon), with

less than one-ninth of the foreign matter contained in the purest water supplied to London, that of Chelsea. If all other sanitary conditions in Glasgow were on a par with the water-supply, one might naturally conclude that the mortality among the people living on the banks of the Clyde, receiving a daily average supply of about fifty gallons of water per head, would not mount up to 28, 29, 30, and 31 per thousand as it frequently does;* indeed it is one of the rarest things imaginable for the Glasgow death-rate to fall below 28 per thousand. Unfortunately, however, the river on whose banks Glasgow is built is still a *cloaca maxima*, a great common-sewer, into which the refuse, filth, and abominations of the city are freely discharged, so as to make the harbour, during summer more especially, a seething cauldron from which putrid exhalations arise to poison the atmosphere, and slowly but surely to poison the people who are compelled to breathe it. Glasgow has shown a good example to London by its Loch Katrine water scheme, but it has yet to learn from the Metropolis how to improve its condition in respect of the great project of intercepting the sewage-matter and conveying it to such a distance as will prevent it exerting any detrimental influence on the health of the people, and possibly to such a part of the West of Scotland as will be directly benefited by its fertilizing power.

However unfortunate the present state of things in Glasgow may be, still there is room for hope that it cannot exist much longer, and sanitary reformers even think that they already almost see the "beginning of the end." In the course of last year the authorities embraced in the Town Council, the Police Board, and the Clyde Trustees, jointly agreed to remit the consideration of the whole question of the sewage to Mr. J. F. Bateman, the engineer-in-chief of the Loch Katrine Water-works; Mr. Bazalgette, the engineer of the Main Drainage and Thames Embankment schemes; and Profesor Anderson, chemist to the Highland and Agricultural Society of Scotland. The gentlemen just named have been devoting a good deal of attention to the subject; and in the month of February last the two eminent engineers spent some days in Glasgow in giving audience to persons who take an interest in this life-and-death question. That the subject has excited a vast amount of local interest (and deservedly so) may be inferred from the fact that during the past winter there has existed an organization called "The Association for the Consideration of the Sewage Question." It embraces in its membership Town Councillors, engineers, chemists, physicians, manufacturers, merchants, and others. Meetings have been held regularly every fortnight, at which papers, treating on almost every conceivable plan, have

* Even in the mild weather of January last, the death-rate per thousand of the population was during five weeks, respectively, 27, 33, 32, 31, and 32.

been read and discussed with much energy and intelligence. Abstract reports of the papers and discussions have been published in the local papers, and, as a matter of course, the interest felt in the subject is very general among intelligent people. The wet systems and dry systems, water-closets and earth-closets, the separation of liquid from solid sewage, house from street sewage, and the refuse of chemical works from both, irrigation and discharging into the sea, have all had their advocates; and frequent references have been made to Croydon, London, Carlisle, Wolverhampton, Paris, Naples, the Craigentinny Meadows at Edinburgh, and other illustrations of more or less successful attempts to dispose of the sewage refuse of large communities. It is to be hoped that the proceedings of the Glasgow Sewage Association may soon be published, so that any valuable information contained in the papers and discussions may be placed at the disposal of other people who are interested in sanitary progress. It is likewise to be hoped that the eminent engineers already named may soon mature such a plan for Glasgow and the Clyde as will be a pattern to other large towns that have the same difficulty to overcome as still meets the sanitarian in the Scottish commercial metropolis.

Apart from the two questions already referred to, a good deal of sanitary work is being accomplished in Glasgow by and through the Police Board, and especially by the Sanitary Department. Acting on the maxim that bad drainage and damp, dark, ill-ventilated, and overcrowded dwellings are a fruitful source of typhus fever, the members of Dr. Gairdner's Sanitary Staff are continually on the alert to check and remove the causes of this and other forms of epidemic disease. But with all their alertness, typhus is constantly asserting its presence in the midst of the community. During last year, no fewer than 3,143 cases of fever were reported to the Sanitary Committee of the Police Board, as against 3,541 in 1866, 7,707 in 1865, and 4,294 in 1864. A large number of the fever cases are treated in the Fever Hospital, erected especially for the treatment of free patients a year or two ago. In it there are 120 beds, of which only 20 were reported to be unoccupied at the end of January last. The numbers of cases of fever reported at some of the fortnightly meetings held in December, January, and February last, are 156, 144, 165, 176, 189. Small-pox also shows itself in Glasgow, for in December, 1867, there were as many as 35 cases reported, notwithstanding that Jenner lived, and that medical schools since his day have never ceased to indoctrinate their pupils in the sanitary truths which he taught and practised during his professional career.

At a recent meeting of the Glasgow Police Board, attention was called to the existence of a range of buildings close to the West-end Park, in a district otherwise entirely occupied by the wealthy mem-

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bers of the community. The buildings were spoken of as intended for dwelling-houses, one story in height, in a narrow lane closed up at each end, and to which access can only be had by means of a covered passage. We say "intended," for at the time of the report they were not ready for occupation. Will it be believed that in enlightened Glasgow, with its boundless wealth, its hundreds of churches and other institutions of a religious, moral, and philanthropic character, that dwelling-houses *placed back to back*, without any provision for ventilation, could be erected in the year of grace 1868, and that under the eye of the police authorities? We may well ask, of what use is the Glasgow Police Act, passed in the year 1866?

It will be seen from the foregoing remarks, that there is not much of a very favourable character to report regarding Glasgow from a Public Health point of view. Of the sanitary state and prospects of other towns in Scotland much might be said, were there sufficient space at our command. All that is possible under the circumstances is a very brief reference to a few points of the greatest interest.

During a large part of the last twelvemonth, the city of Edinburgh has undergone such a minute and systematic visitation and inspection as have revealed a social and sanitary condition so hideous that one is tempted to regard with great doubt many of the statements just recently made at a meeting where the formal reports of the visitation committees were submitted to discussion and for approval. The movement originated in April last, with Lord Provost Chambers, of the eminent publishing firm. In his remarks as chairman at the meeting referred to, he said:—"We have called attention to the gross condition of the lower classes of Edinburgh—the intemperance, the want of proper houses, the discomfort of their dwellings, the want of proper air, light, and water, the demoralizing influences which prevail throughout the city in many ways, and the appalling fact, more particularly, that one in every nine of the population is a pauper! That is a very distressing thing."

Dr. Alexander Wood directed attention to the total absence of water and water-closets in the houses of many of the poor, and mentioned that some of the new houses which had recently been erected for the poor had the same defects as the old houses, referring especially to some buildings in the classic Canongate, where there are 33 families living in 35 rooms—including 24 children under five years of age and 101 adults—with no sink, water, or water-closet. The rooms, it seems, in which whole families live, average about 10 feet square. Another speaker, Sir James Y. Simpson, made the astounding statement that in Edinburgh—the "modern Athens"—there are 60,000 people—one in every three of the population—living in houses of one room only. That is some-

thing like sacrificing one or two of the inhabitants by preventible disease daily. It is sincerely to be hoped that Sir James Simpson's statistics are wrong, and that Edinburgh is better than it is painted. From one of the reports read at the meeting, the following data regarding the mortality and density of the population are taken :—

Districts.	Deaths per 1000.
Lower New Town	15·47
Broughton	17·
Grange	13·78
Grassmarket	32·52
Tron	34·55

and in some tenements in the last-mentioned districts, the mortality amounts to 60 per 1,000 of the population.

Districts.	Population per acre.
Lower New Town	95·4
New Town	21·2
Grange	7·5
Grassmarket	237·6
Canongate	206·7
Tron	314·5

and it is confidently affirmed that in some of the districts of Edinburgh the density of the population is so great as to be unequalled in any town in Britain. Is it any wonder that Mr. Chambers should have determined to mark his magisterial reign by an Improvement Act, to root-out the fever-haunted dens and other plague-spots that form such a hideously foul blot on the boasted piety and refinement of Edinburgh? The Act secured powers in the last session of Parliament for borrowing 350,000*l.*, and for laying on as the *maximum* annual assessment fourpence per pound for twenty years, the same to be paid in equal proportions by the owner and the occupier. The Act is now being put in force by the Improvement Commissioners, and a sum of 50,000*l.* is to be placed at their disposal this year. When the report referred to is published, it will doubtless excite much surprise beyond the limits of the city with which it deals.

The thriving and important town of Dundee acquired an unenviable notoriety during the cholera epidemic of 1866, owing to the ravages made amongst the people in the district of Lochee. Hitherto this district has been proverbial for its periodical visitations of epidemic disease, and it has practically been a separate district from Dundee in respect of drainage and drainage rates. Indeed it has hitherto had neither the one thing nor the other. While Dundee proper has been most completely and effectually drained, the effects of which were seen in its almost total exemption from cholera at the last visitation, and have for some years been

seen in the less virulent character of other epidemic diseases, its Lochee suburb has been growing more and more densely populated, and its want of drainage, its overcrowding, its nuisances, and its general insanitary state have at last led to a revolt, and action is now being taken by the Police Commission under the provisions of the Public Health Act (1867). In the face of that Act the nuisance-mongers sink into utter nothingness.

It is probable that the same cholera epidemic produced a greater proportionate amount of misery in the town of Leven, Fifeshire, than in any other town in the kingdom. It was terribly fatal, so fatal, indeed, that the people fled in great numbers from the plague-stricken spot, and left it comparatively deserted. The town was all but without sewerage, and the well-water, on which the people almost entirely depended, was found to be strongly impregnated with putrefying animal matter, which had percolated through the soil from the numerous cesspools. Such direful results as attended the non-observance of the ordinary rules of health roused the people to a sense of their danger, and in March, 1867, they resolved on adopting Provost Lindsay's Police and Improvement Act (1862). Commissioners were appointed, and the requisite measures taken to carry out the provisions of the Act. Already a bountiful supply of excellent water is introduced into the town, and now the commissioners are proceeding with the necessary drainage improvements. Leven is one of the most pleasantly-situated watering places in the ancient kingdom of Fife, and it promises soon to be one of the tidiest towns in Scotland, to be no more, it is to be hoped, a hotbed of epidemic disease.

It is a hopeful sign to notice the general anxiety prevailing throughout Scotland with regard to the adoption of measures to improve the Public Health. Where other statutory authority does not exist, the Acts of 1862 and 1867 are being called into requisition, and in various places a supply of water is brought in where it is wanted; drainage works are being constructed; nuisances removed, and sanitary inspectors and medical Officers of Health appointed. Stumbling-blocks, however, of various kinds are here and there showing themselves; but the right will ultimately come to the surface. Upwards of eighty towns and populous places have already adopted, in whole or in part, the General Police and Improvement Act (1862). Amongst the other places in Scotland in which there are signs of sanitary commotion, we may, in conclusion, mention the following:—Aberdeen, Montrose, Nairn, Hawick, Aberdour, Thornhill, Elgin, Pennicuik, Galashiels, Perth, Paisley, Greenock, Kirkcaldy, Dysart, and Vale of Leven.

Quarterly List of Publications received for Review.

1. The Variation of Animals and Plants under Domestication. By Charles Darwin, M.A., F.R.S. 2 vols. 8vo. *With Engravings.* *Murray.*

2. Faraday as a Discoverer. By John Tyndall. With Portrait. 175 pp. Post 8vo. *Longmans & Co.*

3. A System of Medicine. Edited by J. Russell Reynolds, M.D., F.R.C.P. Lond., Professor of the Principles and Practice of Medicine in University College. Vol. II., containing Local Diseases. 1,000 pp. 8vo. *Macmillan & Co.*

4. Life of Sir John Richardson, C.B., LL.D., F.R.S., Inspector of Naval Hospitals and Fleets. By the Rev. John McIlraith, Minister of the English Reformed Church, Amsterdam. 290 pp. Fcap. 8vo. *Longmans.*

5. British Social Wasps: an Introduction to their Anatomy and Physiology, Architecture and General Natural History. By Edward Latham Ormerod, M.D., Caius College, Cambridge, Physician to the Sussex County Hospital. 280 pp. Post 8vo. 14 *Plates.* *Longmans.*

6. The Mineralogist's Directory: A Guide to the Principal Mineral Localities of Great Britain and Ireland. By Townshend M. Hall, F.G.S. 180 pp. Post 8vo. *E. Stanford.*

7. Chemical Notes for the Lecture Room on Heat, Laws of Chemical Combination, and Chemistry of the Non-Metallic Elements. By Thomas Wood, Ph.D., F.C.S., Chemical Lecturer at the Brighton College. Second Edition. Post 8vo. 120 pp. *Longmans & Co.*

8. The Primitive Inhabitants of Scandinavia. By Sven Nilsson. Third Edition. Edited by Sir John Lubbock, Bart., F.R.S. 16 *Plates.* 350 pp. 8vo. *Longmans & Co.*

9. The World as Dynamical and Immaterial; and, the Nature of Perception. By R. S. Wyld, F.R.S.E. 235 pp. Post 8vo. *Edinburgh: Oliver & Boyd.*

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10. A Manual of Inorganic Chemistry, arranged to facilitate the Experimental Demonstration of the Facts and Principles of the Science. By Charles W. Eliot and Frank H. Storer, Massachusetts Institute of Technology. Second Edition. 660 pp. Crown 8vo. *With Engravings.* *Van Voorst.*

11. First Principles of Modern Chemistry. A Manual of Inorganic Chemistry, for Students and for Use in Schools and Science Classes. By W. J. Kay-Shuttleworth. 220 pp. Crown 8vo. *Churchill & Sons.*

12. A Treatise on Frictional Electricity, in Theory and Practice. By Sir William Snow Harris, F.R.S. Edited, with a Memoir of the Author, by Charles Tomlinson, F.R.S. 119 *Wood Engravings.* 320 pp. 8vo. *Virtue & Co.*

13. On the Pathology and Treatment of Albuminuria. By Wm. H. Dickinson, M.D., Cantab. Assistant-Physician to St. George's Hospital and to the Hospital for Sick Children. 10 *Plates.* 290 pp. 8vo. *Longmans & Co.*

14. Jerrold, Tennyson, and Macaulay; with other Critical Essays. By James Hutchison Stirling, LL.D. 245 pp. Post 8vo. *Edmonston & Douglas.*

15. Principles of Geology. By Sir Charles Lyell, Bart., M.A., F.R.S. Tenth Edition. Vol. II. 660 pp. 8vo. *Murray.*

16. A Sketch of a Philosophy. Part II., Matter and Molecular Morphology. 75 *Diagrams.* 116 pp. 8vo. *Williams & Norgate.*

PAMPHLETS, PERIODICALS, AND PROCEEDINGS OF SOCIETIES.

Guinea Worm, or Dracunculus: its Symptoms and Progress, Causes, Pathological Anatomy, Results, and Radical Cure. By James Africanus B. Horton, M.D. Edin., Staff Assistant-Surgeon of H.M. Forces in West Africa. 50 pp. 8vo. *John Churchill & Sons.*

On certain Moral Aspects of Money-Getting. By W. T. Gairdner, M.D. 47 pp. 8vo.

Experimental Investigations connected with the Supply of Water to Calcutta. 38 pp. 8vo. By D. Waldie, F.G.S.

On the Spectrum of the Bessemer Flame. By W. M. Watts, D.Sc. *Plate.* 4 pp. 8vo.

The Present Position of Opinion respecting the Geology of Devonshire. By W. Pengelly, F.R.S. 37 pp. 8vo.

The Antiquity of Man in the South-west of England. By the same Author.

On the Distribution of the Devonian Brachiopoda of Devonshire and Cornwall. Same Author.

The Raised Beaches in Barnstaple Bay. Same Author.

On the Deposits occupying the Valley between the Braddons and Haldon Hills, Torquay. Same Author.

On the Floatation of Clouds, and the Fall of Rain. Same Author.

Notes on the Meteoric Shower of November, 1866, with Speculations suggested by it. Same Author.

On a Thermometer unaffected by Radiation. By Dr. J. P. Joule, F.R.S.

Hints to Certifying Surgeons under the Factory Acts. By George Greaves, M.R.C.S. *Knight & Co.*

Harvesting in Wet Weather. By W. A. Gibbs.

On an Improved Method of dividing Alcohol and other Thermometers. By William Ackland. 4 pp. 8vo.

The Annual Meeting of the Miners' Association of Cornwall and Devonshire. *With Engravings.*

Proceedings of the Essex Institute. (Salem, Massachusetts.)

Transactions of the Geological Society of Glasgow.

The Medical Record. (New York.)

The Mining Gazette. (Halifax, Nova Scotia.)

Le Mouvement Médical.

The American Naturalist.

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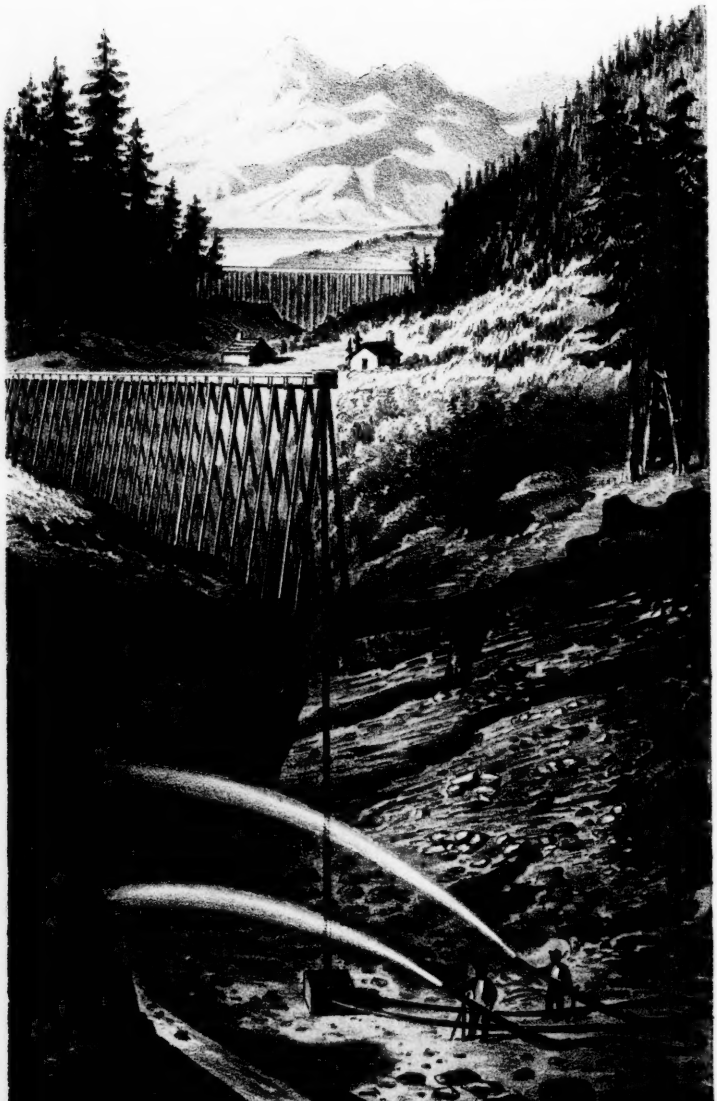

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